MeterBuilder™ MB-1
PROGRAMMABLE
RF POWER METER

USER'S MANUAL

Version 1.01
Updated May 2014

Patent and Copyright Notices

Patent Applied For

Copyright

FIGURES

TABLES

1 Introduction

1.1 How to Use this Manual

Don't be intimidated by the size of this manual. You should be able to use most of MB-1's power meter functions after reading the following two sections:

- Introduction - Section 1
- Quick Start Guide – Section 2

MB-1 contains lots of features, and we erred on the side of providing more detail than advanced users will probably need. But we view this as the lesser of the two evils.

Before using the Analog Panel Meter, you will have to adjust the two Panel Meter trim pots as described in section 2.9. You will also have to adjust two coupler trim pots for use with the included MB-HF1 coupler using the DC voltage factory benchmarks printed on the coupler. This is a simple operation, and can be done using just a multimeter. This procedure is described in section 6.

The remainder of the manual is organized as follows:

Section 3 is primarily for reference. It provides detailed descriptions for each of the 19 menus and eight setup screens. An overview of most of this material is given in the Quick Start Guide.

Section 4 describes miscellaneous topics such as loading special configuration settings at Startup, disabling the Screensaver, and the convention used for displaying high power measurements (> 10,000 watts, or > 10,000 user-defined units for Generic Meter Applications).

Section 5 provides detailed instructions on adding and calibrating your own Couplers.

Section 6 provides detailed instructions on adjusting the coupler trim pots.

Section 7 describes how to use MB-1 to measure RF current.

Section 8 provides detailed instructions on adding and calibrating your own external analog Panel Meters.

The other sections in the document provide reference information that you will find useful if you want to experiment with some of MB-1's advanced features. We think that you will find MB-1 to be an accessory you will not get quickly bored with.

If you are interested in how MB-1 can be used with analog sensors to measure a wide range of parameters not related to RF power measurements, see the Generic Meter Example in section 5.6 of this manual and the User Manual for Using MB-1 with Analog Sensors.

1.2 General Overview

The MB-1 power meter provides a level of customization and programmability that you will not find in any other power meter. MB-1 can display eight measurement types simultaneously. In addition, MB-1 has extensive analog and digital display capabilities and a flexible menu structure that allows you to map almost any measurement to any display device.

Unlike most new Amateur Radio products, MeterBuilder encourages "tinkering" by providing lots of room for customization and expansion. You can add your own Couplers and Panel Meters, including analog meter scales and faces of your own design. You can also add high-visibility 7-segment displays and a high-visibility bar graph display to enhance readability at a distance.

In addition to conventional power and SWR measurements, you can program any of MB-1's four coupler ports to measure RF current when used with a suitable RF current sensor. In fact, with the appropriate analog sensor, you can use MB-1 to calibrate and display just about any parameter that can be mapped to a positive DC voltage, even if the sensor's output is a nonlinear function of the parameter being measured.

MB-1's options and settings are easily managed with a one-button restore to factory settings and a one button "save" of the current meter settings to a ***user defined Startup set.*** The Startup settings are restored each time the meter is powered up. In addition, five other user-defined backup/restore configuration sets are available to customize as you see fit. Each configuration set can provide MB-1 with a completely different personality.

Some of MB-1's more interesting features are listed below:

- *MB-1 supports both instantaneous and average power*, with averaging window control.
- The measurement algorithms incorporate extensive digital filtering for stable and repeatable measurements.
- MB-1 has an effective low range resolution of 15 bits – unmatched by any of the other popular digital meters.
- Each of the four coupler ports support up to 60 power level calibration points on the Reference Band, and up to nine power level compensation points *each for the other bands*. The ***Reference Band*** is one of the amateur bands that you select during calibration (e.g., 80 meters), on which you will perform the master calibration on. This may be done at up to 60 distinct power levels.

  Individual Band Compensation for each of the remaining amateur bands makes use of the Reference Band calibration data as well as calibration data performed at up to nine different power levels on each of band. With careful calibration, this scheme provides unmatched accuracy across a wide range of both power levels and frequencies.

- Custom Panel Meters – Up to 50 point Analog Meter calibration is used for meters with non-linear scales. This allows you to add almost any analog meter movement with a full scale sensitivity of 1 mA or less to MB-1 regardless of its scale linearity (including crossneedle meters).

- Fast Response Times – Fast acting display devices, such as the analog meter and bar graphs, can track voice and CW signals. Surprisingly, this is not the case with some of the high end digital power meters currently on the market.

- Bar Graph AutoMax – Causes the Bar Graph to dynamically adjust to your current maximum output power. No more changing to the "best compromise range" every time you change power.

- Soft Overrange – Allows you to observe an overrange condition on an analog meter without risking damage to the meter movement by deflecting the needle safely past its full scale value.

- Min/Max function – Select a parameter of interest, and have MB-1 monitor its maximum and minimum value (similar to the *Monitor Minimum and Maximum* capability of the Bird 4391A Digital Power meter).

- RF Current measurement capability with an appropriate RF current sensor.

- MB1's Generic Meter capability allows you to calibrate MB-1 to display measurements for a wide range of applications using analog sensors as long as the signal is in a positive DC voltage, or can be converted to a positive DC voltage.

The complete specifications for MB-1 are given below.

1.3 Specifications

Table 1 - MB-1 Specifications

General	
Display Devices	4 x 20 LCD Four 4-digit 7-Segment Display Modules Crossneedle Analog Meter – with *Linear Power Scales*
Expansion Features	Add up to four additional single needle Analog Meters (or up to two additional crossneedle meters) Add two large High Visibility 7-Segment Displays or one High Visibility 7-Segment Display and One High Visibility 40 Segment Bar Graph Display module MB-1 supports the full family of SURE 7-segment information modules (from 1.5 inches to 7 inches in height)
Number of Remote Coupler ports	4 (each port has its own power and band compensation settings)
Measurements	
Power measurement range	10 mw – 2000 watts with included MB-1 coupler Up to 30,000 watts with appropriate user-provided coupler
VSWR range	1.0 – 99.9
SSB SWR Stabilizer (Provides stable SWR readings, even for time varying signals such as SSB an CW)	
Min FWD Power Required for SWR Measurements	100 mw
Supported Measurements	Instantaneous Forward Power Instantaneous Delivered Power

	Average Forward Power Peak-Forward Power Peak-Delivered Power Reflected Power SWR Min/Max Functions RF Current Generic Meter - supports a wide range of applications with user-defined calibration
Simultaneously Displayable Measurement Types	8
Measurement Type-to-Display Device Mapping	Programmable
Averaging Filter Window for Averaging Power Measurements	.3 seconds – 8 seconds, with configurable "Snap Measurement to Constant Signal" feature
Maximum Measurement Rate	> 500 measurement cycles per second - for time varying signals > 300 measurement cycles per second with constant level signal applied above specs apply for Default settings)
Adjustable Peak Hold Time	.1 sec - 9.9 secs in steps of .1 sec
Adjustable Panel Meter Downrange Decay Time (when in AutoRange mode)	.1 sec - 9.9 secs in steps of .1 sec
Variable Display Update Rates	Three speed controls - 9 Speed Settings for each of the following Displays: ▪ Numeric Displays ▪ Bar Graph ▪ Panel Meter

Effective Low Range A-to-D Resolution	15 bits
Digital Filtering	4 Filters: ▪ Instantaneous FWD Power ▪ Instantaneous Reflected Power ▪ Average Power ▪ SWR
Couplers	
Frequency Range	HF + 6 Meters with included MB-HF1 Coupler No restriction with User-provided Bruene type coupler
Power Range (for included MB-HF1 coupler)	1500 watts HF (ICAS), 1000 watts 6 Meters (ICAS)
Maximum Full Scale Capacity of Control Head	Maximum display value of 30,000 watts with user-provided coupler Maximum display value of 30,000 "user defined units" when used for a user-provided analog sensor
Maximum coupler distance from control head	150 feet (using shielded RCA cables). No recalibration required when extending distance.
Restrictions on external Couplers	Works with most Bruene-type DC directional coupler with a FWD and REFL DC port with a Full Scale DC output of approx 1 volts or more. (> 6 volts FS DC required for full 15 bit resolution)
Max number of Calibration points (Reference Band)	Up to 60
Band Selection	Manual
Frequency Correction supported on the following bands	160, 80, 60, 40, 30, 20, 17, 15, 12, 10, 6, 2 meters 70 cm
Multiple Power Level Correction trim points for each of the above bands	Nine Power Levels (Six for Amateur Radio) 5w, 50w, 150w, 500w, 1000w, 2000w, 5000w, 8000w, 15000w

Preloaded Calibration Table for included MB-HF1 Coupler	
Number of Active (in memory) Coupler Calibration Tables	4 – With pushbutton recall
Coupler Field Calibration Method	Simple Multimeter lineup with included MB-HF1 Coupler using Factory Benchmarks
Coupler Port Input Sensitivity	Full Scale voltage of approx. 6.14 volts can drive full 15 bit range with trim pot set to maximum sensitivity (max CW travel)
Max Input Voltage to coupler port	200 volts peak 100 volts continuous
Analog Meters - Details	
Responsiveness	Real time tracking of Voice and CW
Maximum Distance from control head	150 feet with shielded RCA cables
Cross Needle Meter Support	Yes
Auto range	Fast attack slow decay for up-ranging/down-ranging. Adjustable down-range timing
Number of Programmable Power ranges per meter	1 – 12 ranges for Linear Scale Analog Meters 1 – 3 ranges for Non-linear Scale analog meters (including Crossneedle meters)
Number of Programmable SWR ranges per analog meter	1 – 3 ranges for Linear Scale Meter Movements 1 range for Non-linear Scale Meter Movements
Required Meter Movement sensitivity for user-provided external add-on analog meters	1 mA or less
Meter Movement protection	Yes – with Soft Overrange
Overrange Indicator	Yes – Soft Overrange on Analog Meter and LED overrange Indicator on Control Head.

Scale Restrictions of meter face	Can accommodate almost any scale – linear or nonlinear. Each scale can be mapped at up to 50 points during calibration. Also supports user designed scales.
Bar Graph - Details	
AutoMax Bar Graph	Bar Graph Full Scale Value adjusts dynamically to maximum applied signal
Number of Manual Power ranges	Up to 5 (Full scale value of each range is programmable)
Number of Manual SWR ranges	Up to 3 (Full scale value of each range is programmable)
Number of BAR Graph Segments	Internal Bar Graph (LCD) – 60 segments External High Visibility Bar Graph Module – 40 segments
Response Type	Linear
"Sticky Bar" Segment (freezes max bar)	Can be enabled/disabled for ***all*** supported Bar Graph measurements, not just Peak power.
Sticky Bar Variable Hang Time	.1 sec - 9.9 secs in steps of .1 sec (Slaved off of Peak Hold Time setting)
SWR/Relay Protection	
Devices	Relay, Sounder, Both (User selectable from menu)
Trip Parameters	SWR High Power Trip Low Power Trip RF Current (for RF Coupler Applications) High Power/Low Power Trip Points can be used to alarm Generic Meter Applications as well
Alarm Relay Jacks	6 RCA Jacks (2 sets, each with set of N/O and N/C contacts)
Max contact Switching/Load	.5 Amps at 30 VDC

SWR Trip Points	1.1 - 9.9 in steps of 0.1
Adjustable Fault Trip Duration for High Power/Low Power Trip Points	Yes (50 ms - 30 secs)
Low Power Trip Points	1 watt - 27,500 watts
High Power Trip Points	1 watt - 30,000 watts
Number of SWR Alarm threshold sets	Up to 7 – A different group of trip settings can be stored in each of the seven Configuration sets.
Alarm Trip Reset – 3 modes ▪ Manual ▪ Auto Reset ▪ Conditional Auto Reset	Auto Reset unconditionally resets alarm after user specified interval. Conditional Auto Reset resets alarm after timer expires ***only if none of the monitored parameters exceed the user defined trip thresholds***.
Auto Trip Reset Interval	Adjustable from 50 ms - 30 secs
SWR Alarm "Snooze" mode	Adjustable from 5 – 99 seconds
SWR Alarm-Low Power Bypass	Adjustable from .1 watts – 10 watts
SWR Warning Feature	Independent of Trip feature. Provides non-latch LED indication when SWR threshold is exceeded. SWR "Trip" and SWR "Warning" thresholds have their own settings.
"SWR-Changing" Indicator	LED Lights when the SWR filters detect a change in SWR value, and is performing processing on the FWD and REFL power measurements to arrive at a new SWR value.
Alarm Functionality available when used with RF Ammeter and Generic Meter Applications	Full report and alarm trip functionality using the low and high level trip points.
Miscellaneous	

Power	12 – 15 volts at 800 mA amp (base meter) 12 – 15 volts at 1.2 amps (with external Hi Visibility Display Modules connected) Power connector 2.5 mm coaxial power plug (Tip +).
Firmware Field Upgradeable	Yes
PC-Based Utility - to Backup and Restore MB-1 EEProm settings	The entire User Section of the EEProm image can be backed up and restored.
PC- based OEM Calibration Table update utility	Allows updating of the preloaded OEM coupler calibration tables to add updates and support for new coupler types.
Backup/Restore Configuration sets	7 Sets Default Set – (with one button restore) User-Defined Power-Up Set – (with one button “save” and one button “restore”) 5 additional User-Defined Configuration Sets
Baud Rate for Firmware Upgrade and EEProm backup/restore utilities	115,200
Integrated Diagnostic Mode	Interactive Hardware diagnostics with results displayed on LCD
Demo Mode - Integrated Simulator with four Virtual Coupler Ports	6 Demo Modes Three Virtual power couplers - with programmable Full Scale Power and programmable SWR. One of the virtual couplers generates “variable SWR” values. One Virtual RF current coupler with programmable Full Scale current. This virtual coupler can also be used to test and exercise Generic Meter Applications.
Min/Max Functions	Select the parameter to be processed by the Min/Max function

	(e.g., SWR), and the Min/Max feature will capture the Min and Max values for display on any of the available display devices.
Prototyping Features	Auxiliary Power (5 volts) – 500 mA when no Ext Displays connected 50 uA, 200 uA and 1 mA current source (for External Analog Meter check out) Variable output voltage (0 – 5 v) controlled from front panel pot
Screensaver	Adjustable Activate time - 1 minute to 9 minutes. Screensaver can be completely disabled.
LCD Brightness LCD Contrast 7-Segment Brightness (internal 7-segment modules)	9 Settings 9 Settings 9 settings
Performance Metrics	Measures Meter Update Rate and displays the values on the LCD
Size (Width x Height x Depth)	9 x 5.5 x 7.7 inches
Weight	10.2 lbs

1.4 Controls and Displays

The figures below show the location of the operating controls, displays and jacks:

Figure 1 – Front Panel

Figure 3 – Rear Panel

Figure 4 – Right Side Panel (Coupler Trim Pots)

Figure 5 - Left Side Panel (Analog Meter Trim Pots)

1.4.1 Front Panel

The front panel consists of the following:

Crossneedle Meter –Simultaneously displays Forward and Reflected Power, allowing you to read SWR directly from the intersection of the two needles. The forward and reflected scales are linear - a feature not generally found on crossneedle meters.

For RF Power applications that do not involve reflected power measurements, such as peak power, average power, delivered power, and Min/Max values, only the forward scale (and needle) is used. The forward scale can be also be used when displaying RF current and when using MB-1 with other analog sensors.

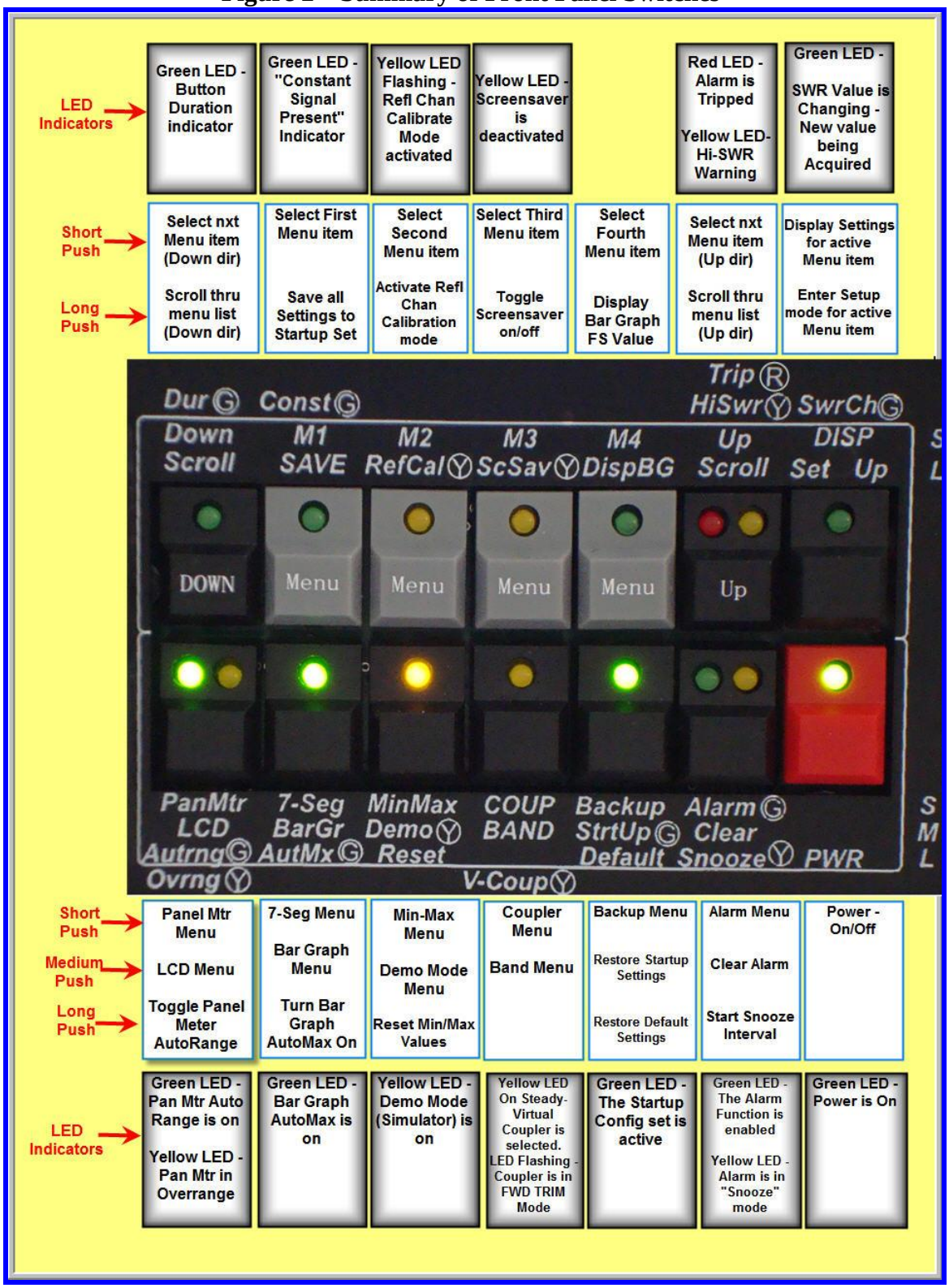
7-Segment Displays – The meter contains four 4-digit 7-segment displays. Each Display can be individually programmed to display a different measurement or configuration value (such as the currently selected coupler number, or the current full scale value selected by the Analog Meter's AutoRange function).

4 x 20 LCD – The LCD was originally intended solely for setup and control functions, such as calibration of the Couplers and Panel Meters. During development, we displayed all the key measurements values on the LCD for troubleshooting purposes, and ended up with a useful and highly configurable measurement display. We decided to leave it in the product. The LCD can be turned off if desired.

Buttons/Switches – The front panel layout is shown in Figure 1. The front panel switches allow you to quickly access and change a meter setting. Some of the front panel switches are multifunction switches, which perform multiple operations based on the duration they are pushed. A summary of the front panel switches is given in Figure 2.

Figure 1 – Front Panel

Figure 2 – Summary of Front Panel Switches



1.5 Switch Functions

With the exception of the On/Off Power Switch, most switches are multipurpose switches capable of performing up to three operations based on how long the switch is pushed (short, medium, or long push). The text above and below the switches in the above figure specifies the function that each switch controls as follows:

Top row of Switches:

- Top entry – The operation that is performed with a short press
- Bottom entry – The operation that is performed with a long press (greater that 2 seconds)

Bottom row of Switches:

- Top entry – The operation that is performed with a short press
- Middle entry – The operation that is performed with a medium press (greater than .7 seconds)
- Bottom entry – The operation that is performed with a Long press (greater that 2 seconds)

The **S,L** and **S,M,L** legends shown to the far right of the switches, and the corresponding items above and below the switches identify the functions that each switch (at the corresponding duration) provides. For example, the lower left switch performs one of three actions based on how long it is pushed:

- Short Press – selects the Panel Meter Menu on the LCD
- Medium Pres – selects the LCD Setup menu on the LCD
- Long Press - Toggles the Panel Meter AutoRange function on/off

1.6 LED Indicators

Most switches have LED indicators. These LEDs indicate the status of key meter functions. For example, the Green LED below the bottom left switch, when lit, indicates that the Panel Meter AutoRange function is on. The Yellow LED on the same switch, when lit, indicates that the Panel Meter is in an Overrange condition (the value being measured exceeds the Panel Meter's current full scale range – useful when the AutoRange function is not active). The circled R, G and Y legends above and below the switches identify what each switch LED is indicating when lit. For example, the bottom left switch has two LEDs. The Green LED is illuminated when the Panel Meter's ***AutoRange*** function is on. The Yellow LED on the same switch is illuminated when the Panel Meter is in an ***Overrange*** condition.

Note that yellow and red LEDs on the front panel switches are used to indicate non-standard or abnormal conditions. An example of an ***abnormal*** condition would be a tripped alarm or overrange condition. An example of a ***"non-standard"*** condition would be when the meter is in "Demo" mode, or when a Virtual Coupler (vs. a real coupler) is selected. If you are not seeing what you expect on the meter, do a quick check for ***any illuminated yellow or red LEDs*** to make sure for example, that the demo mode is not on when you are trying to use the meter for normal operation.

A detailed description of all of the switch functions and LED indicators is given in the tables below.

Table 2- Front Panel Switch Functions

Top Row of Switches			
Switch Name	**Short Push**	**Medium Push**	**Long Push**
Down/ Scroll	Moves **down** one menu item. Used to select the desired menu.	Pushing and holding this button causes the menu on the LCD to continuously scroll ***down*** through the list of menus. Release the button when the desired menu is selected.	
M1/SAVE	Selects the first of up to 4 menu values when a menu is displayed on the LCD. Used when modifying a meter setting with the menu system.		Saves the full meter configuration in the ***Startup Set***. These saved settings will be automatically restored whenever the meter is powered up.
M2/RefCal	Selects the second of up to 4 menu values.		Toggles the "Reflected Channel Calibration" mode. You need to activate this mode when adjusting the Reflected Channel trim pot during calibration of a power coupler.
M3/ScSav	Selects the third of up to 4 menu values.		Toggles the Screensaver on and off.
M4/ DispBG	Selects the fourth of up to 4 menu values.		Temporarily displays the current full scale vale of the Bar Graph. This is particularly useful when the bar graph is in ***AutoMax mode***, where the bar graph's full scale value is being controlled dynamically, and the Bar Graph is covering the area where the full scale value is normally displayed.

Up/ Scroll	Moves **up** one menu item. Used to select the desired menu.	Pushing and holding this button causes the menu on the LCD to continuously scroll ***up*** through the list of menus. Release the button when the desired menu is selected.	
DISP/ Set-Up	***Displays*** key configuration information for the menu item that is currently selected on line 4 of the LCD. For example, when the Panel Meter menu is displayed on the LCD, pressing this button provides summary information for the currently selected Panel Meter, such as the number of ranges and full scales values of each range. Some displays have multiple pages of information. For these cases, each short press advances to the next page of information.		Places the meter in a ***setup mode*** for the menu item that is currently selected on line 4 of the LCD. For example, when the Panel Meter menu is displayed on the LCD, pressing this button activates the Panel Meter calibration screens, which allow you to calibrate the Panel Meter, or to edit its previous calibration settings.

Bottom Row of Switches

These buttons allow you to quickly access commonly used menus, or in some cases, change key meter settings without the need to use the menu functions. These buttons are referred to below as "shortcut" buttons.

Switch Name	Short Push	Medium Push	Long Push
PanMtr/ LCD/ Autrng	Selects the ***Panel Meter*** setup menu.	Selects the ***LCD*** setup menu.	Toggles the Panel Meter ***AutoRange*** function on/off.

7-Seg/ BarGr/ AutoMx	Selects the setup menu for the ***7-segment*** Displays.	Selects the setup menu for the ***Bar Graph***.	Turns the Bar Graph ***AutoMax*** function on. If AutoMax is already activated, a long push will instead reset the current full scale ***AutoMax*** value. This is useful when you have lowered power of your station and want the AutoMax function to adapt to the new lower power level. To turn AutoMax off, simply select the desired manual range from the Bar Graph menu.
MinMax/ Demo/ Reset	Selects the menu for the ***Min/Max function***, which allows you to capture the largest and smallest value of a selected parameter, such as average power, or SWR.	Activates the menu for the Demo mode, which uses an inboard simulator to drive the meter without running live.	***Resets the Min/Max*** values thereby starting a new capture interval.
COUP/ BAND	Selects the menu for the ***Coupler.*** This allows you to select one of four real couplers for normal operation, or one of four virtual couplers for use with the integrated simulator.	Selects the ***BAND*** selection menu. If you have performed band correction while calibrating a coupler, you can specify any of the bands where the band correction has been performed.	
Backup/ StrtUp/ Default	Selects the c***onfiguration settings menu***, which allows you to save and restore up to six custom sets of settings, and one default set.	***Loads the startup set*** of configuration settings (without the need to power cycle the meter).	***Loads the factory default set*** of configuration settings.
Alarm/ Clear/ Snooze	Selects the menu for the ***SWR/Alarm*** Trip functions.	***Resets an Alarm trip condition***.	Activates the ***snooze*** mode, which causes the meter to bypass any trip conditions for a user-specified interval.
PWR	Powers the meter on/off		

Table 3- LED Indicators on Front Panel Switch Functions

LEDs on Top Row of Switches (from Left to Right)			
Switch			
Down/ Scroll	***Duration indicator*** – Since the front panel switches are multipurpose depending upon the interval the switch is pushed, this LED will flash each time an interval expires. This will allow you to reliably select the correct interval to choose a desired function.		
M1/SAVE	***Constant Signal indicator*** – Lit when the software has detected that the incoming signal is (approximately) constant. This is used during the Reflected Channel calibration procedure to ensure that the reading has reached its final (stable) value when adjusting the reflected channel trim pot.		
M2/RefCal		This LED will flash repeatedly to remind you that the "***Reflected Channel Calibration***" mode is activated.	
M3/ScSav		***The screensaver is deactivated***.	
Up/ Scroll		***Hi-SWR*** – The SWR exceeds the user-defined warning level. The SWR warning level is independent from the thresholds set for the alarm trip function.	Alarm has ***tripped***. – The SWR and/or power level are outside of the user-defined thresholds.
DISP/ Set-Up	***SWR-Changing*** – This LED is lit when the SWR has changed and the software is in the process of acquiring a new value. This was a useful development tool that we left in		

	the product. It is turned off by default.		
LEDs on Bottom Row of Switches (from Left to Right)			
Switch			
PanMtr/ LCD/ Autrng	The Panel Meter ***AutoRange*** function is activated.	The Panel Meter is in an ***overrange condition*** (most useful when manual scales are selected for the Panel Meter).	
7-Seg/ BarGr/ AutoMx	The Bar Graph ***AutoMax*** function is activated.		
MinMax/ Demo/ Reset		The meter is in "Demo Mode" The meter software is therefore processing simulated measurement values (vs. signals from one of the four real coupler ports).	
COUP/ BAND		**If the yellow LED is on (continuous):** one of the ***Virtual Couplers*** *(*Coupler 5 – 8) is selected. When a real coupler is selected (Coupler 1-4), this LED is off. **If the yellow LED is flashing:** This indicates that you have placed coupler in the TRIM mode, which allows you to easily fine tune the FWD power calibration by +- 1% using the high precision front panel pot.	
Backup/ StrtUp/ Default	The currently selected configuration set is the ***Startup configuration set.***		
Alarm/ Clear/ Snooze	The ***Alarm function is enabled***.	The meter is currently in the "***snooze***" interval.	
PWR	The meter power is on.		

1.6.1 Rear Panel

The rear panel consists of the following:

Coupler Inputs – Signals from each coupler (RF power coupler, RF ammeter, or analog sensors) are connected to the RCA jacks on the rear panel.

Panel meter Outputs – Signals to drive user-provided external analog meters are connected via the RCA jacks on the rear panel.

SWR Alarm Jacks – Two sets of double pole - double throw contacts are provided on RCA jacks. These may be wired to amplifiers or other devices that you wish to control with the alarm trip function.

Test Signals – A number of current and voltage sources are provided to aid you with meter customization and prototyping. For example, the current sources allow you to easily determine the full scale current of an external panel meter that you may be considering for use with MB-1. You can view the **50 uA** and **200 uA** jacks as current sources as long as the resistance of any meter movement being connected to the source is low (usually the case).

Front Pot - The two RCA jacks labeled **FR POT** are connected to the center wiper of the high precision front panel pot and provide a variable voltage of 0 – 5 volts through a 5.1K resistor.

5 Volt Power - The two RCA jacks labeled **+5v** are connected to the Auxiliary 5 volt power supply bus, and can be used to provide a low power source of regulated DC for prototyping. If you decide to use these 5 volt jacks for prototyping, be careful. The only protection against short circuits is the fuse in the 12 volt input line. Also, if you accidentally plug an external analog meter movement into one of the 5 volt power jacks, this could damage the meter movement. Therefore, it is recommended that you place two blank RCA plugs into the two 5 volt auxiliary power jacks to prevent this from happening. Remove them only when you need to access the 5 volt auxiliary power source. (Two blank RCA plugs are included with the Expansion Kit).

The rear panel layout is shown in Figure 3.

Figure 3 – Rear Panel

1.6.2 Right Side Panel - Coupler Trim Pots

Eight 15-turn Coupler trim pots (two for each coupler) are accessible from the right side of the meter. These are adjusted during the coupler calibration procedure to provide maximum sensitivity and resolution for a given coupler. The coupler trim pots are shown below. These trim pots have no mechanical stops.

Figure 4- Coupler Trim Pots

1.6.3 Left Side Panel - Panel Meter Trim Pots

Six Panel Meter trim pots are accessible from the left side of the meter. These are adjusted during analog meter calibration based on the full scale current rating of the analog meter movement. The two pots closest to the front of the case are used to set the full scale current of the forward and reflected needles of the internal crossneedle meter. The remaining four pots are used to control the full scale current of up to two external crossneedle meters, or up to four external single needle meters. These controls are shown below.

Figure 5- Panel Meter Trim Pots

2 Quick Start Guide

2.1 Overview

If you have not done so already, it is recommended that you first spend a few minutes reading the Programming MB-1 link on the MeterBuilder website. It is essentially a high level summary of the information covered in this walkthrough.

Operation of the meter will be straightforward if you understand the basic rules of the user interface.

To control most meter settings, you need to follow two simple steps:

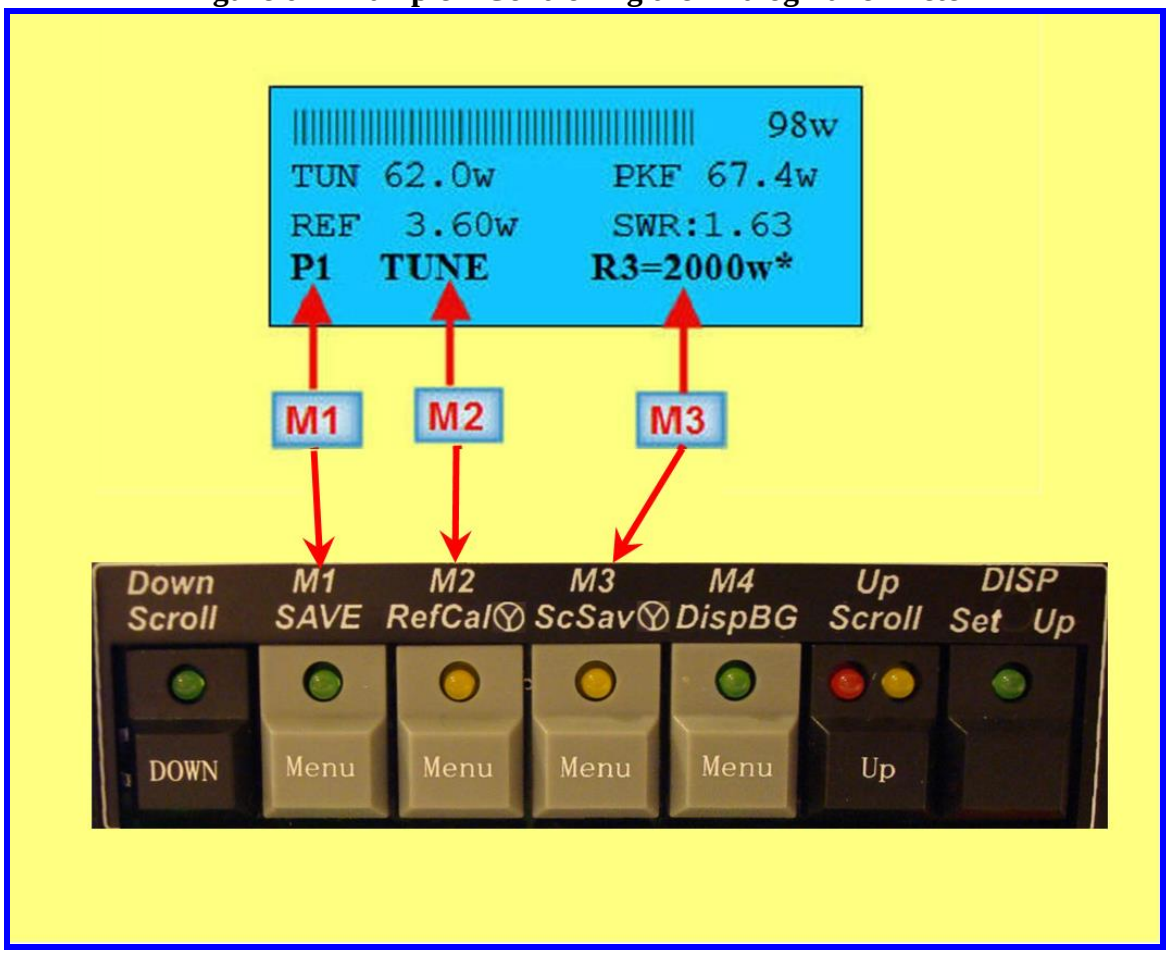
1. Select the menu for the item you wish to control. Do this by pushing the ***Down Scroll*** or ***Up Scroll*** buttons shown in the figure below. Each of the menus will scroll, in alphabetical order, on line 4 of the LCD. Release the scroll button when the desired menu is displayed. If you overshoot the desired menu, each single push of the ***Down Scroll*** or ***Up Scroll*** button will advance the menu up or down to the next menu.

2. When the desired menu is displayed on line 4 of the LCD, press one of the four menu buttons, M1 through M4 to make selections from the first through fourth menu items respectively from the menu on line 4 of the LCD.

A typical use of a menu would be to control a display device. You would first select the device of interest (e.g., Panel Meter, 7-Segment Displays, Bar Graphs) by bringing up the relevant menu on line 4 of the LCD. Using menu buttons M1 through M4, you would then specify the measurement type you want to display on the selected device as well as other options relevant to the current display device.

An example is given below:

Figure 6 – Example – Controlling the Analog Panel Meter



The example above shows the menu that controls the Analog Meter functions. Menu buttons M1 - M3 correspond to the three positional items on line 4 (***menu items are separated on line 4 of the LCD by one or more spaces***). The Panel Meter menu in this example has only three fields. Therefore, M4 is not used with this menu.

- In this example, menu button 1 (M1) selects the Panel Meter (MB-1 supports multiple Panel Meters). Panel meter 1, which is the internal crossneedle meter, is selected in the above example. Each press of the M1 button selects the next available panel meter if you have configured some external Panel Meters.

- M2 selects the measurement type that will be displayed on the selected Panel Meter. TUNE (Instantaneous power) is selected in the above example. Each press of this button will select the next available measurement type to display.

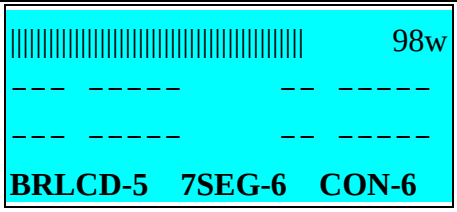
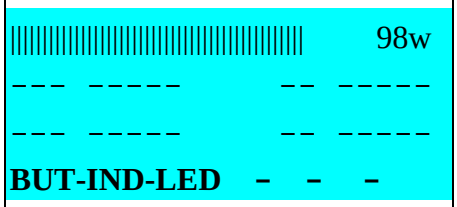
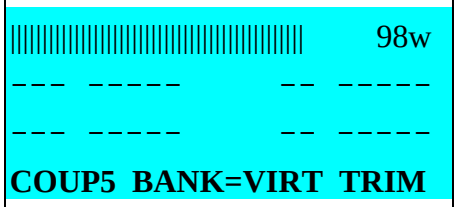
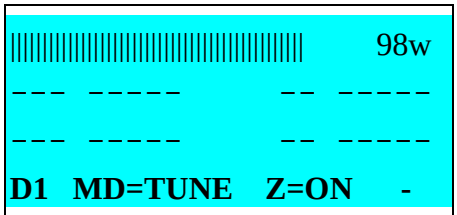
- M3 selects the Panel Meter manual range. (In the above example, the third range (2000 watts) is being controlled by the AutoRange function. (When the AutoRange function is on, this is indicated by the asterisk to the right of the range.) When M3 is pressed, the AutoRange function (if enabled) will be turned off, and the set of manual ranges that you

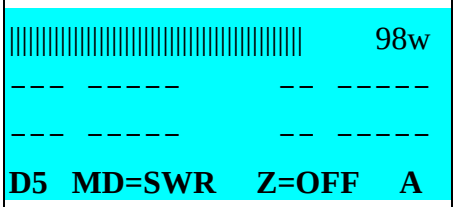
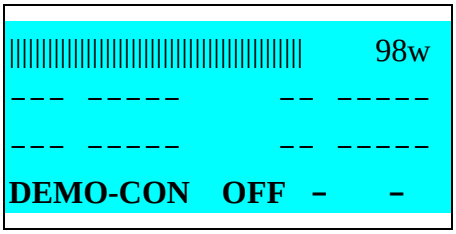
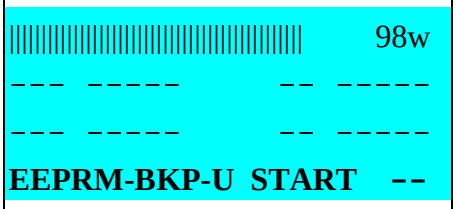
set up during calibration of the analog meter is made available for selection. Each subsequent press of this button will select the next available manual panel meter range.

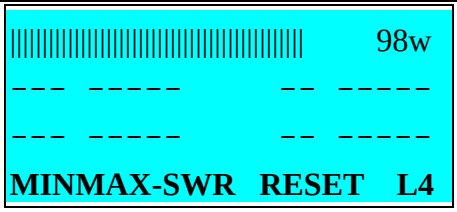
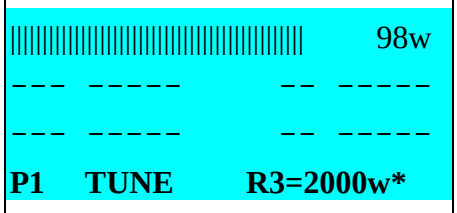
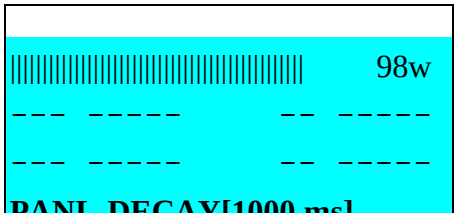
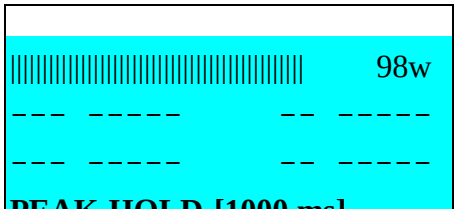
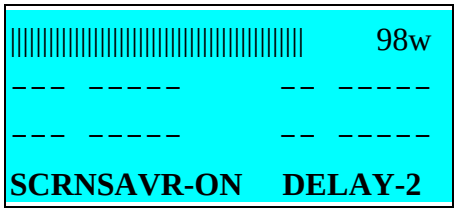
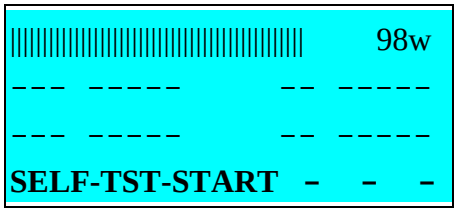
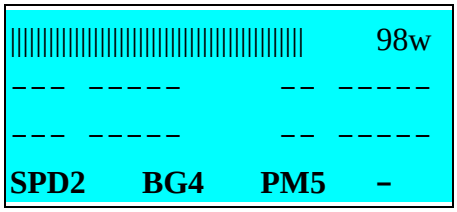
A summary of the complete set of MB-1 menus is given in Table 4 below. Each of these menus is described in detail in section 3.

Table 4 – Quick Start Guide – Summary of Menus

Menu Name	Sample Menu (Menu appears on line 4 of LCD)	Description	Display Function is Applicable (Short push of the **Display/Setup** button.	Setup Function is Applicable (Long push of the **Display/Setup** button.
Alarm	98w --- ----- -- ----- --- ----- -- ----- **ALARM-OFF CLEAR - -**	Controls Alarm Functions.	Yes	Yes
Averaging Filter	98w --- ----- -- ----- --- ----- -- ----- **AVFLT SS-OFF CHS-OFF**	Sets up Averaging Parameters. Also toggles Constant Signal (Steady State) indicator and "SWR Changing" indicator on/off.	Yes	Yes
Band Select	98w --- ----- -- ----- --- ----- -- ----- **BAND-6mtr COR=1.074**	Selects the band and applies and displays real time band correction factors if band correction was performed during calibration of the coupler.	Yes	No (Band correction is done as part of Coupler calibration)
Bar Graph	98w --- ----- -- ----- --- ----- -- ----- **BGINT AVG AUTO SOFF**	Controls the Bar Graph functions for both the internal Bar Graph (LCD) and the external Hi Visibility Bar Graph module if installed.	Yes	Yes
Backup Meter Configuration	98w --- ----- -- ----- --- ----- -- ----- **BKSET=0* RST SAV (S)**	Controls Backup and Restore of the Configuration sets.	No	No

Brightness		Controls the brightness of the LCD display and the internal 7-segment displays. Also controls the contrast of the LCD display.	No	No
Button Duration Indicator		Controls the type of indication (audible beep, LED flash, or no indication) that the user receives when initially pushing a multifunction button, and when the medium and long push interval elapse when holding down a multifunction button.	No	No
Coupler Selection		Selects coupler ports 1 through 4 (when the **REAL** coupler bank is selected) or couplers 5 – 8 when the **virtual coupler bank** is selected). When the **REAL coupler bank** is selected, this allows you to select the power coupler or other input device (RF Ammeter Coupler, Analog Sensor) that is connected to the associated coupler port.	Yes	Yes
Digital (Seven Segment) Display Control for Internal 7-segment Modules (1-4)		Specifies the measurement type or configuration value to be displayed on each of the four internal seven segment display modules.	No	No

Digital (Seven Segment) Display Control for Hi-Visibility External Display Modules (5 – 6)		Same as above, but the ***external*** 7-segment modules (modules 5 and 6 if configured), have a fourth field ("TYPE" identifier, e.g., A) that is used to select the correct software driver based on the type of external module that is connected to the rear panel IDC connectors. (The different size display modules use one of four different drivers.)	No	No
Demo Mode		Places meter in Demo mode, activating the on-board simulator, allowing you to select one of six pseudo random measurement modes.	Yes	Yes
EEPROM Backup and Restore Utility		EEPROM Backup/Restore to/from PC. Also updates OEM Coupler calibration Tables (to support updates in the calibration tables or new coupler types).	No	No
LCD Configuration		Controls the measurement information that is displayed on the 4x20 LCD. Also determines whether the displayed peak power measurements are **Peak FWD** power or **Peak Delivered power** (Peak FWD pwr – Peak REFL pwr). The information on line 3 of the LCD (SWR info or Min/Max info) is also controlled by this menu.	No	No

Min/Max Configuration		Selects the measurement parameter to be processed by the Min/Max function.	No	No
Panel Meter Control		Selects the Panel Meter (Internal or External) and controls Panel Meter options such as the measurement to be displayed and the range.	Yes	Yes
Panel Meter Decay Time Setup		Sets the panel meter decay time (the time delay before the panel meter "downranges" when automatically switching to a lower range when in the AutoRange mode).	No	Yes
Peak Hold Time Setup		Sets the peak hold time for ***all*** display devices that have been configured to display a peak value (e.g., RF power, RF current, Analog Sensor measurement).	No	Yes
Screensaver Control		Controls the Screensaver activate delay time (in minutes), and also allows Screensaver to be totally disabled.	No	No
Self-Test Diagnostics		Initiates the interactive self test routines, which run diagnostics on the meter hardware and display the results on the LCD.	No	No
Speed (Display Update) Control		Sets the rate at which the various display devices are updated.	Yes (Displays Performance Metrics)	No

The easiest way to familiarize yourself with the meter is to place the meter in ***Demo Mode***, and then select various meter functions to see how they behave. The Demo Mode uses an inboard simulator to generate simulated measurements. This allows you to exercise all of the meter functions without the need to connect the meter to a transmitter and load. The simulated measurements drive the meter and display devices in an identical fashion to live operation. ***From this point on, the term demo mode and simulator will be used interchangeably.***

The simulator will be used below in the walkthrough below.

2.2 Button Duration Indicator

Since a number of front panel buttons perform different operations depending upon how long they are pushed, MB-1 provides a ***button push duration indicator*** (Green LED on the top leftmost front panel button **DOWN/Scroll**). When a button is first pushed, the green LED on this button will flash immediately to confirm the initial push. If the button continues to be pushed, the LED will flash again to let you know that the "medium push" interval has been reached. If the button continues to pushed, the LED will flash a third and final time to let you know that the "long push" interval has been reached. By providing this feedback, you should be able to reliably perform "short", "medium" and "long" button pushes on the multifunction buttons.

Try different push intervals on **PanMtr/LCD/Autrng** button to see how this operates. (The medium push interval is approximately .7 seconds, and the long push interval is approximately 2 seconds).

Until you familiarize yourself with the front panel controls, we repeat the following color code convention in this manual:

White – indicates a short push
Yellow – indicates a Medium push
Red – indicates a Long push

Figure 7 - Button Push Duration Indicator and Default Settings Button

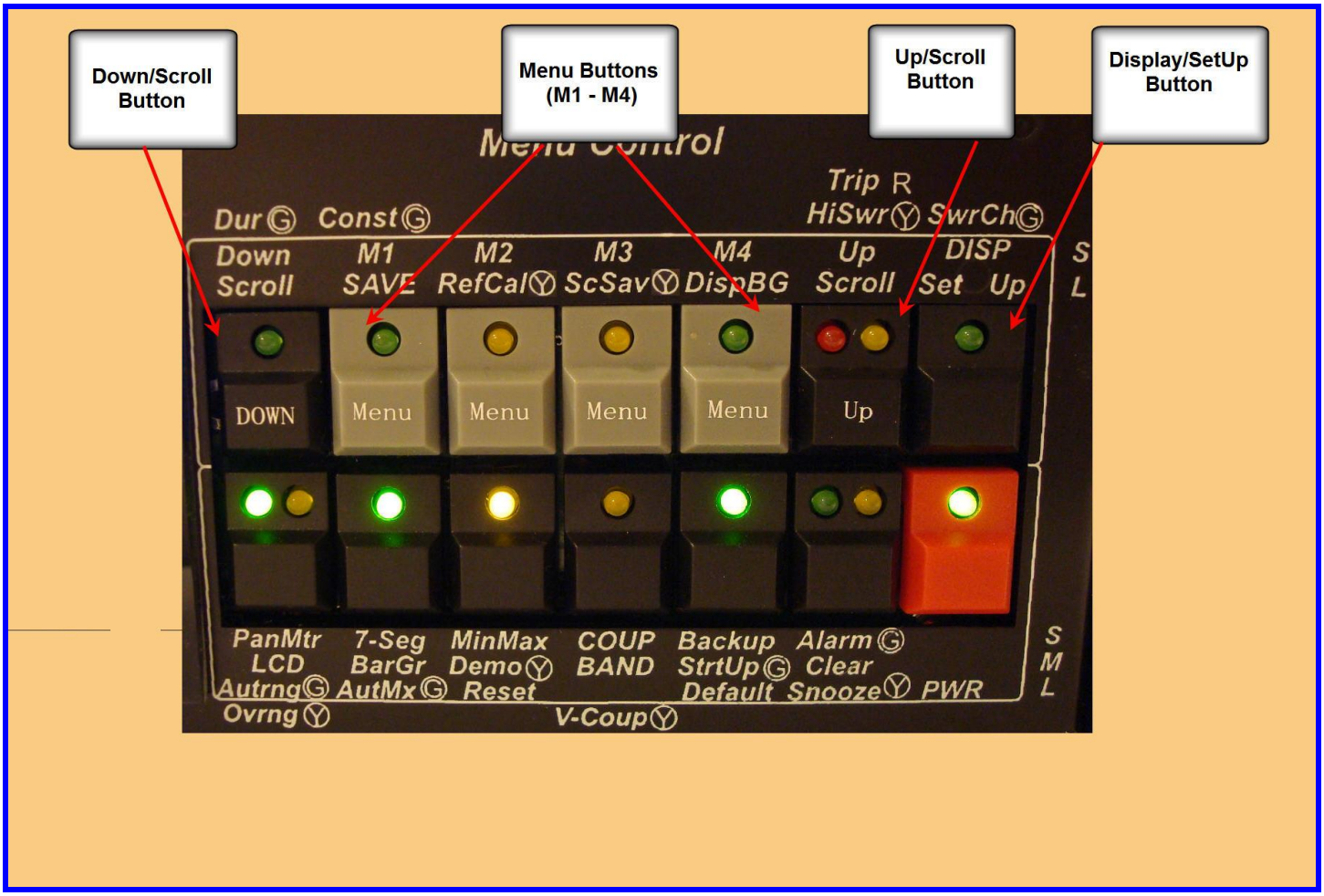
2.3 Restore Default Settings

Since the following walkthrough assumes that the meter is using the Default settings, first restore the Default settings with a long push to the **Backup/Startup/Default** button. The LCD should display a message indicating that the Default settings were restored.

2.4 Menus and Menu Buttons

MB1 has 19 menus. Use the **Up scroll** button **Up/Scroll** and **Down scroll** button **Down/Scroll** to advance the selected menu "up" or "down" respectively. Menus are ordered alphabetically.

Figure 8 - Menu Buttons



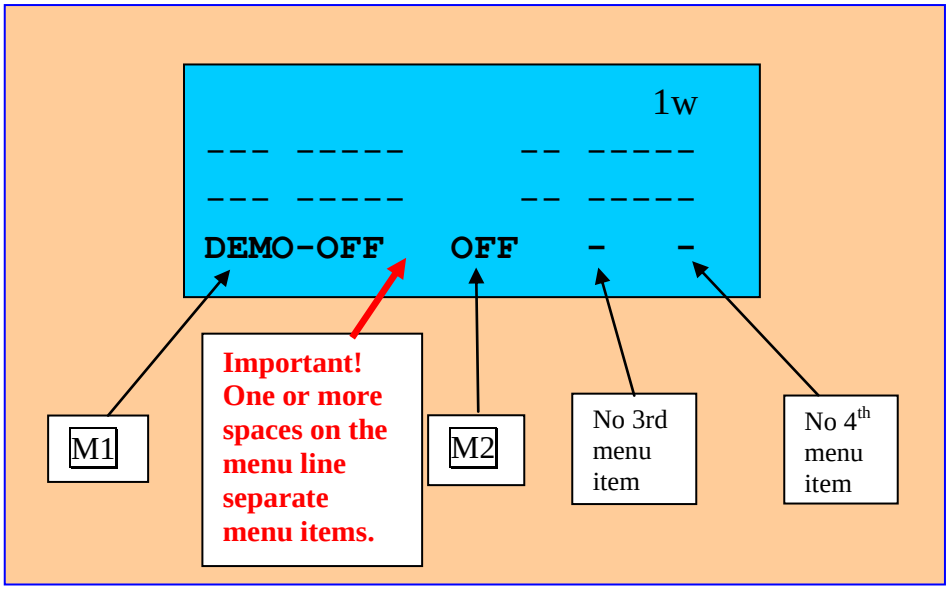
Push the **Up** or **Down** scroll button. A single push will advance to the next menu or previous menu respectively. Pushing and holding either button will scroll with wraparound through the entire set of menus on line 4 of the LCD until the button is released.

Push the **Up** or **Down** button until the **DEMO** menu appears on line 4 of the LCD display as shown in the figure below.

At this point, you push one of the four menu buttons M1 through M4 ***to select an item from the active menu*** (see below). M1 through M4 select the first through fourth items respectively in the menu line as counted from left to right. ***Important – a single menu item is any group of contiguous characters, regardless of how many characters are in that menu item. Therefore, menu items are separated by one or more spaces. Also, because of the variable length of menu items, menu items***

will not always appear directly above their corresponding menu buttons. M1 – M4.

Demo Mode Menu – Demo Mode Off

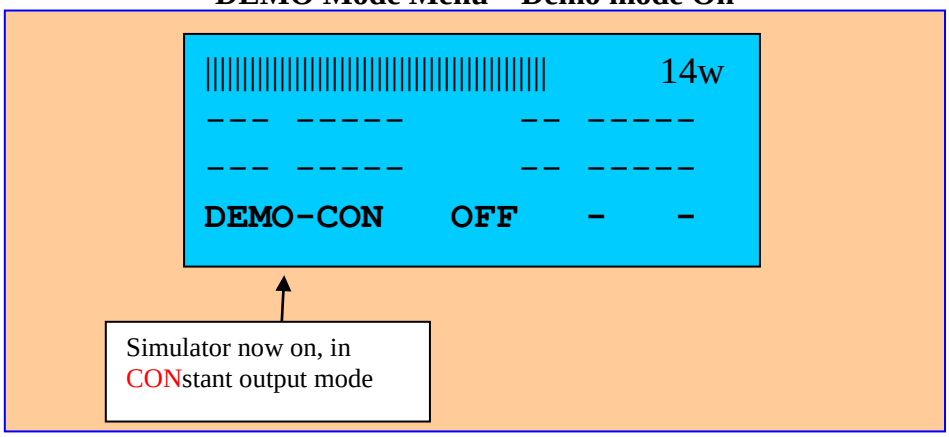


Turn on the Demo Mode:
With the Demo mode menu displayed on line 4 as shown above, turn the Demo mode on by pressing M1 once (short press). The first field of the Demo mode menu selects one of the six simulator modes. The first press will place the simulator in the **DEMO-CON** mode (**CON**stant output mode) - a mode in which the simulator generates a constant stream of pseudo random measurement values that are upper bounded by the current coupler's full scale value. ***The yellow LED on the DEMO shortcut button (bottom row of buttons, third button from the left) will also light to remind you that the Demo mode is on.***

At this point, the meter should be displaying the simulated measurements on the various display devices, and the menu line should appear as shown below. (Don't expect any Panel Meter readings at this point since the default Panel Meter mode is set to OFF.)

As can be seen in the above figure, the second menu item, "**OFF**", provides a quick exit from the simulator with a short press of menu button M2.

DEMO Mode Menu – Demo mode On

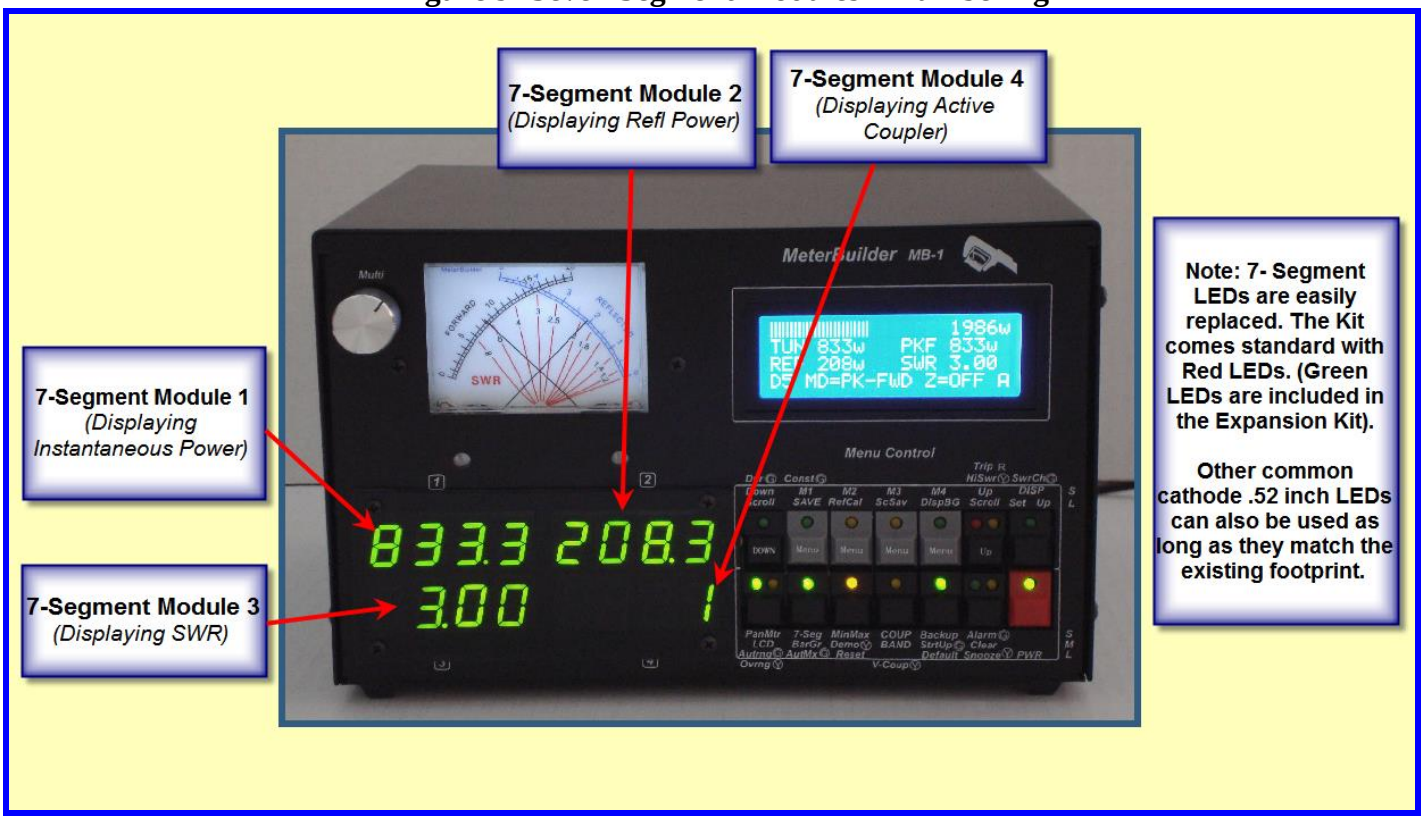


2.5 Seven Segment Module

You can display up to four different measurement types on the internal 7-segement displays, and up to two additional measurement types on the external 7-segment display modules. (Note – the Expansion Kit includes one external 7-segment display module.)

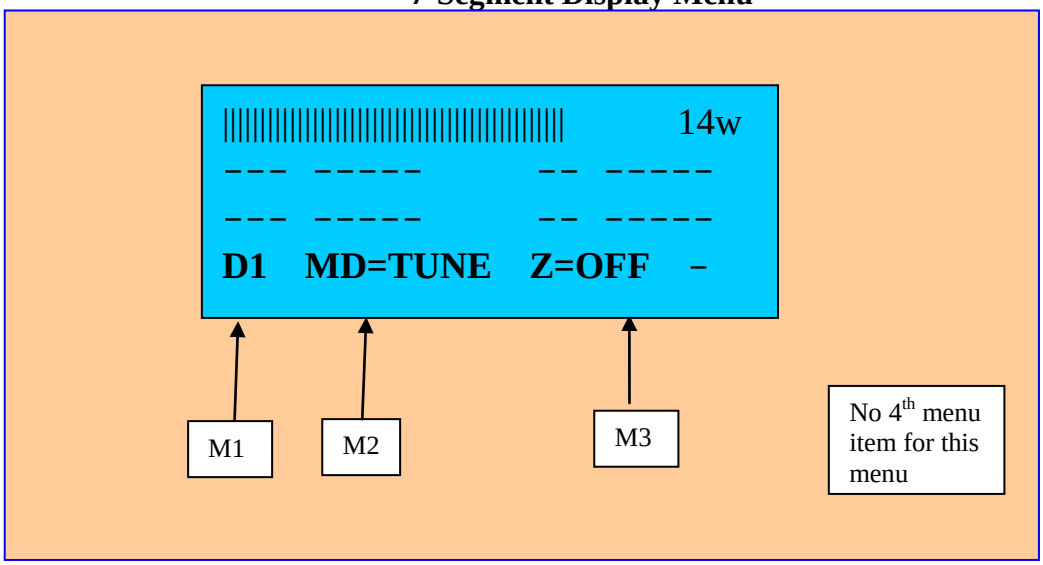
You can also program the meter to display configuration information on any of the 7-segement displays. Examples of configuration information are the current band, the current coupler number, the full scale range currently selected by the Panel Meter's AutoRange function, and the full scale value of the Bar Graph AutoMax function. The four internal seven segment displays are shown in the figure below.

Figure 9- Seven Segment Modules – Numbering



You can activate the Seven Segment Display menu using the UP or DOWN scroll buttons. Alternatively a short press of the 7-Segment shortcut button (described in detail below) will also bring up the Seven Segment menu immediately without the need to use the Up/Down scroll buttons. Use either method to bring up the 7-Segment menu on line 4 as shown below.

7-Segment Display Menu



To set up the 7-Segment Display devices, first select one of the 4 digit display modules D1 – D5 that you wish to configure as shown in the first field on the menu on line 4. Modules D5 and D6 are the two ***external*** 7-segment display modules. If you have configured both external display ports to drive the external 7-segment modules, you will also have a D6 option, which controls the second external 7-segment display module. The factory default for the external display modules is one 7-segment external display and one Bar Graph external display. Therefore, since we are using the default set, field 1 will range from D1 – D5.

Once you have selected the 7-segment module in the first field of the menu, select the item you want to display on that module in the second field. Finally, specify whether you want to display or suppress leading zeros on that module in the third field.

Menu Item 1 - M1 **– Selects the 7-Segement Display Module.** Module **D1** (the first module) is selected in the above example.

Menu Item 2 – M2 **– Selects the item being displayed on the selected display module.** Module 1 is displaying instantaneous (TUNE) power. Press the M2 button repeatedly to cycle through the different display modes as shown in field 2 of the menu. You will see the information being displayed on the selected module (D1) change as you select different measurement or configuration values to display.

Menu Item 3 – M3 **-** Turns leading zeroes **ON** or **OFF** for the selected 7-segment module.

Menu Item 4 – M4 **–** ***This option applies only to the external 7-segment modules (D5 and D6)***. Each type of external module requires a different software driver. Set option field 4 based on the type of external module connected to the corresponding rear panel IDC jacks. Since we are not controlling either of the external 7-segment modules in this walkthrough, the fourth menu field is not applicable, and is set to "– ". (This field will appear automatically when D5 or D6 is selected.) Configuration of the external 7-segment modules is given in section 3.9.

In this walkthrough, we will set up the four internal 7-segment displays as follows:

D1 - TUNE (instantaneous power)
D2 - Peak Power
D3 – Delivered Power (Forward Power – Reflected Power)
D4 – SWR (with leading zeros OFF)

Module D1 and D2 should already be configured as shown above from the default settings. Press M1 repeatedly to cycle through the different display modules and verify that modules 1 and 2 are set up as described above. If not, set them to the desired values using the menu buttons.

To configure modules D3 and D4:
Use M1 – M3 to configure modules D3 and D4 as follows:

D3 – **DEL**ivered Power (Forward Power – Reflected Power)
D4 – SWR (with leading zeros OFF)

Saving settings to STARTUP Set

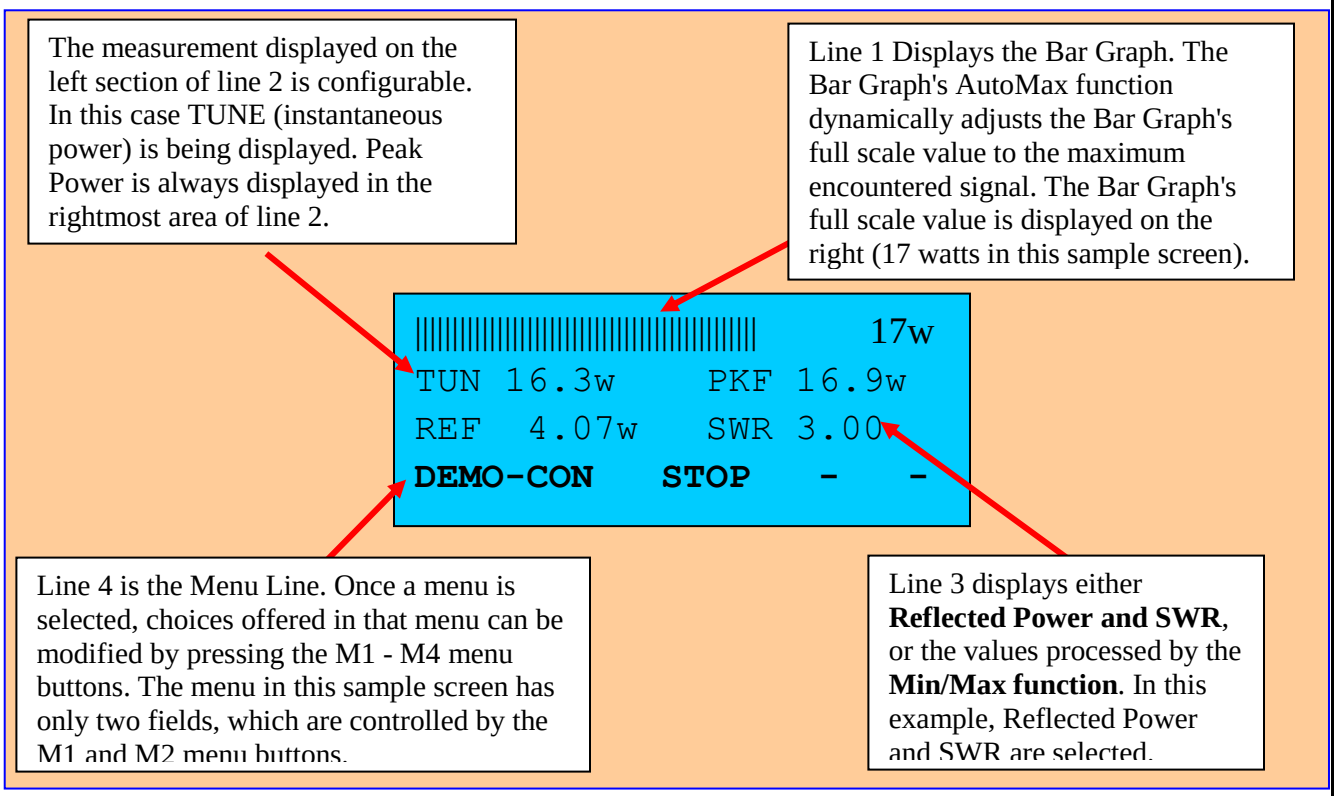
You can save the current meter settings at any time with a long press to M1. Those settings will then be automatically restored whenever you power up the meter.

Since you have just made some modifications to some of the meter settings, this is a good point to save the current settings. Apply long press to M1. You will see a confirmation message on the LCD confirming that the current settings have been saved to the Startup Set. The next time the meter is powered up, the modifications you just made to the 7-segment modules (and any other changes you may have made) will be loaded into the meter.

2.6 LCD Display

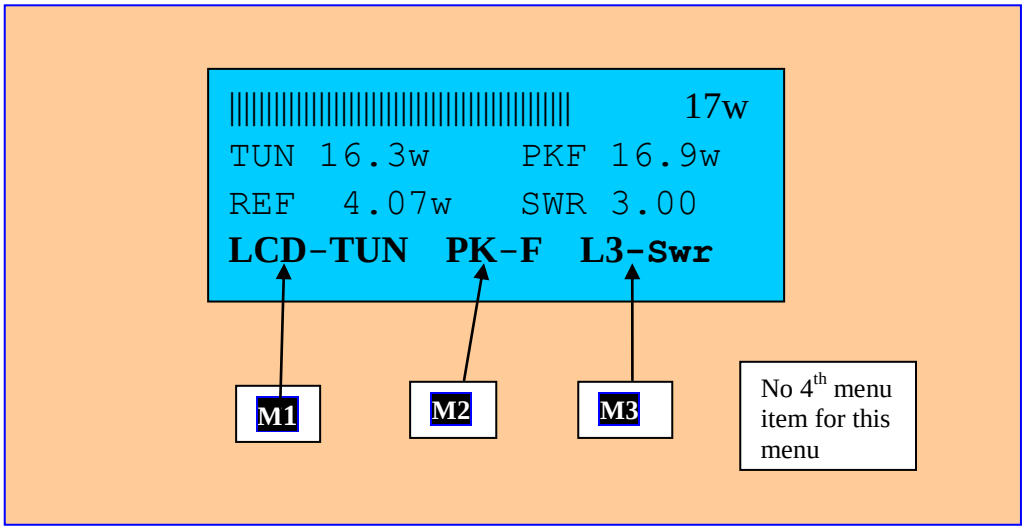
The LCD Layout is shown below. The LCD has four lines (4 x 20 characters). When the meter is in the normal mode (i.e., not displaying a setup screen), the Bar Graph is displayed on line 1 of the LCD and numeric measurements are displayed on lines 2 and 3. The fourth line is reserved for menus as discussed above. A Sample LCD screen is shown below:

LCD Screen Layout with Demo Mode Menu active on Line 4



To control the information being displayed on the LCD, first bring up the LCD menu on line 4.Push the UP or DOWN scroll buttons to bring up the LCD menu on line 4 as shown below.

LCD Menu



Menu Item 1 - M1 – selects the leftmost measurement displayed on line 2 of the LCD. Press M1 repeatedly to sequence through the different measurements that can be displayed in this field. Note that there is an LCD-OFF option as well, which turns off the entire LCD display (except for the menu line). This is useful if you are using only the analog meter and 7-segment displays. Return the setting to **LCD-TUN** before proceeding.

Menu Item 2 – M2 - selects the type of peak power being displayed. The choices are *Peak Forward power*, or *Peak Delivered power* (peak forward power – peak reflected power). This choice is global – that is, all peak power measurements, regardless of the display device, ***will display the peak power type selected with this setting***. A **PKF** or **PKD** indication is displayed on the right side of line 2 of the LCD to indicate that either peak **F**orward or peak **D**elivered power is selected respectively. In the above example, Peak **F**orward power is selected and being displayed on the right hand side of line 2. When you change the Peak mode by pressing M2, an informational message will be temporarily displayed on line 1 of the LCD to confirm the change as well.

Menu Item 3 – M3 - selects the measurements that are displayed on line 3 of the LCD. Line 3 of the LCD can be configured in one of three modes:

- Display Reflected Power and SWR
- Display Min/Max Values (the min and max value for the measurement being processed by the Min/Max function).
- OFF – turns line 3 off completely.

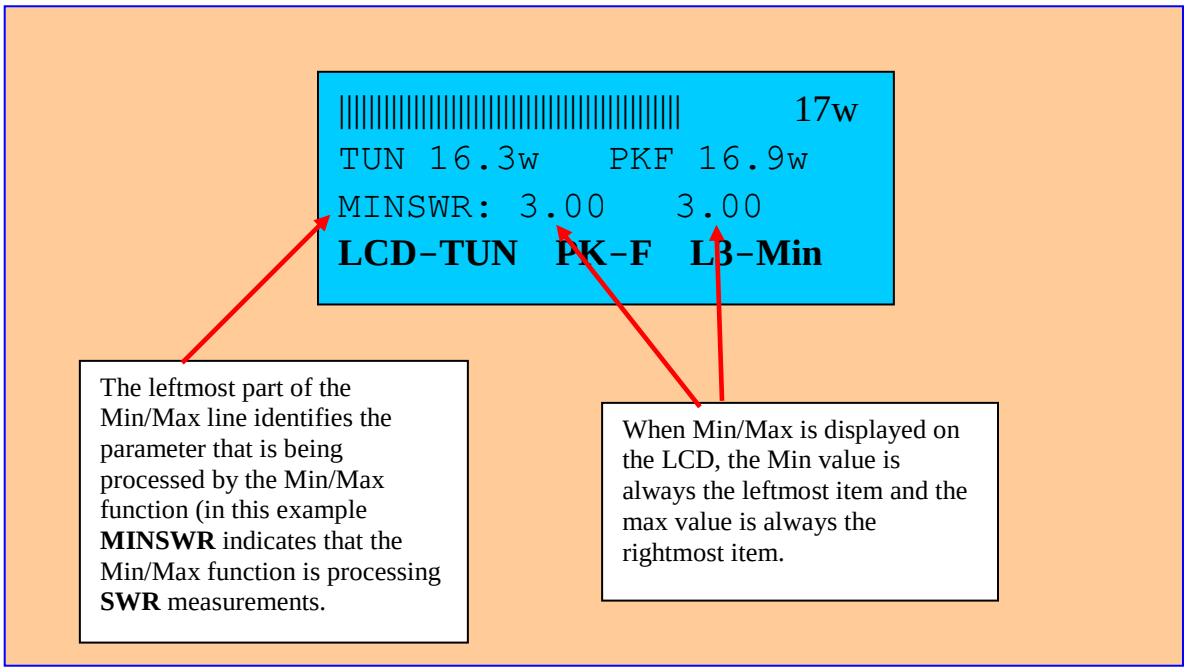
Press M3 repeatedly to cycle line 3 of the LCD through its different display modes. Stop when the Min/Max function is displayed on line 3 as shown below. The default settings for the Min/Max function, which has not yet been discussed, are set to capture the Min/Max values of **SWR**. The LCD is shown below with Min/Max values being displayed on line 3. The ***min value is always displayed on the left hand side of line 3***(***with a heading*** that identifies the value being processed by the Min/Max function*)* and the ***max value is always displayed on the right hand side of line 3*** (***without the heading)***.

(The SWR of the virtual coupler being used so far (coupler 5) is a constant value of 3.0. Therefore the min and max values are the same. We will select a different virtual coupler later in this walkthrough where the coupler provides a variable SWR.)

Save the settings to STARTUP Set

Since you have made some additional changes, save the current meter settings again at this time with a long press to M1. You can then get back to this point easily at a later time by simply power cycling the meter. (You will have to turn the simulator back on whenever you power cycle the meter since the software always powers up with the simulator off.)

Min/Max Values Displayed on Line 3 of LCD

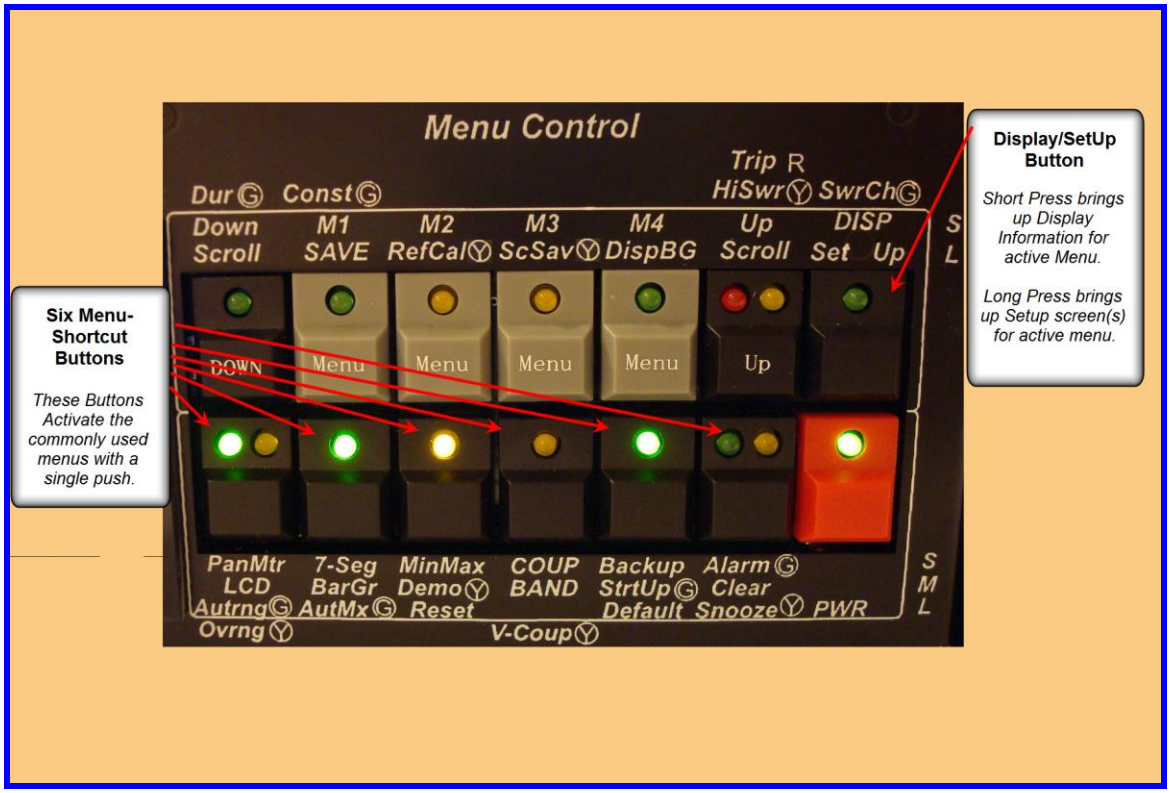


2.7 Menu Shortcut Buttons

IN addition to using the Up or Down scroll buttons to select menus, the commonly used menus can be more easily accessed with a single push of one of the ***Menu Shortcut Buttons, which are located on the bottom row of buttons on the front panel.*** Think of these as being analogous to toolbar buttons in Windows programs, which reduce or eliminate the need to use the detailed Windows menus for commonly used functions.

The six menu shortcut buttons are shown in the figure below. Each of the first four buttons allows you to select one of two menus. The first menu associated with each of these four switches is selected with a short push of the associated button. The second menu is selected with a medium push. The fifth and sixth buttons allow you to quickly select one menu each, which is accomplished with a short button press. The functions of these front panel switches were summarized above in **Table 2**.

Figure 10 - Menu Shortcut Buttons and Display/Setup Button



For example, the leftmost bottom button, **PanMtr/LCD/Autrng**, allows you to access ***either*** the Panel Meter Menu or LCD setup menu. A **short** press will bring up the first of the two menus (Panel Meter menu in this example). A **medium** press will bring up the second of the two menus (LCD setup menu in this example). The last function of this switch, **AutRng**, toggles the Panel Meter AutoRange function on and off when a **long** press is applied.

Each of the last two menu shortcut buttons, **Backup/StrtUp/Default** and **Alarm/Clear/Snooze** are dedicated to a single menu (the configuration settings Backup menu, and the SWR Alarm Protection menu). The menu for each of these buttons is activated with a short push.

Try a short and medium push on any of the dual-use shortcut buttons. Then try a short push on the **Backup/StrtUp/Default** and **Alarm/Clear/Snooze** buttons.

Note:
From this point on, we will reduce the clutter in this manual by referencing only the function being discussed. For example, the Panel Meter shortcut button will be represented **PanMtr** vs. **PanMtr/LCD/Autrng**. The LCD setup shortcut button will be represented by **LCD**; and the AutoRange shortcut button will be represented by **Autrng**. It is understood that the appropriate push interval is required to select that function.

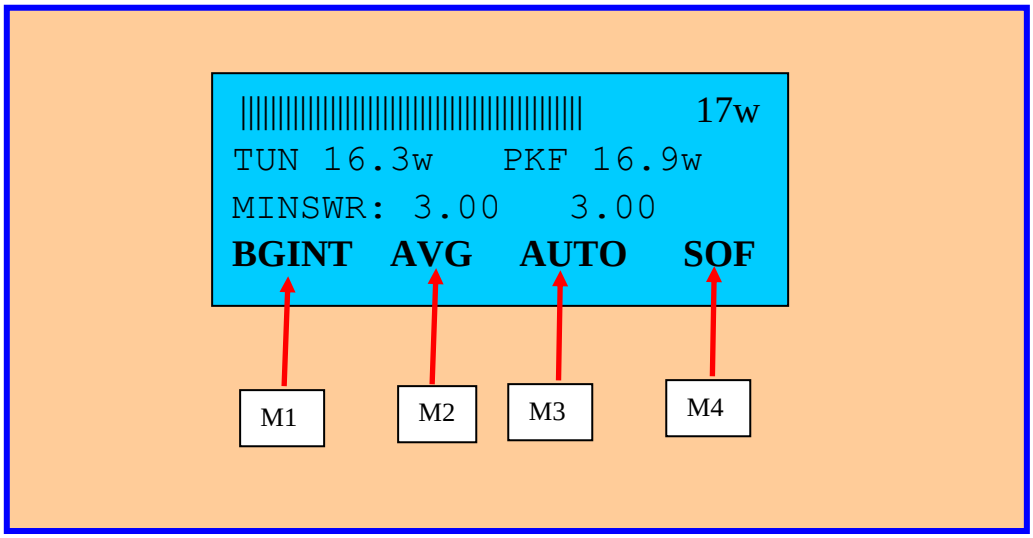
We will continue to use the color codes below as a reminder of the push duration:

- **White – short push**
- **Yellow – Medium push**
- **Red – Long push**

2.8 Bar Graph

Bring up the Bar graph menu using the **BarGr** shortcut button. The Bar Graph menu will appear on line 4 of the LCD with four menu fields as shown below.

Bar Graph Menu



Menu Button 1: M1 controls the Bar Graph display device. The measurement selected for display on the Bar Graph can be displayed on the internal Bar Graph (line 1 of the LCD), the high visibility **EXT**ernal Bar Graph module, or **BOTH** the internal and external Bar Graph devices simultaneously. The Bar Graph output can also be turned off entirely. Press the M1 button repeatedly to cycle through the different Bar Graph display devices. In the above example, the **INT**ernal (BG**INT**) Bar Graph device (LCD line 1) is selected. Make sure you return to the **INT**ernal Bar Graph selection before proceeding.

Menu Button 2: M2 controls the second field in the menu, namely the measurement that will be displayed on the Bar Graph (TUNE, AVG, PK, REFL. OFF, etc). Press the M2 button repeatedly to cycle through the different Bar Graph display modes. You will see the behavior of the Bar Graph change as you select different measurements. In the above example, the measurement being displayed on the Bar Graph is **Average** power. The smooth response of the Bar Graph is a result of the averaging function being displayed. The averaging window can be controlled using the Averaging Filter menu described in section 3.2.

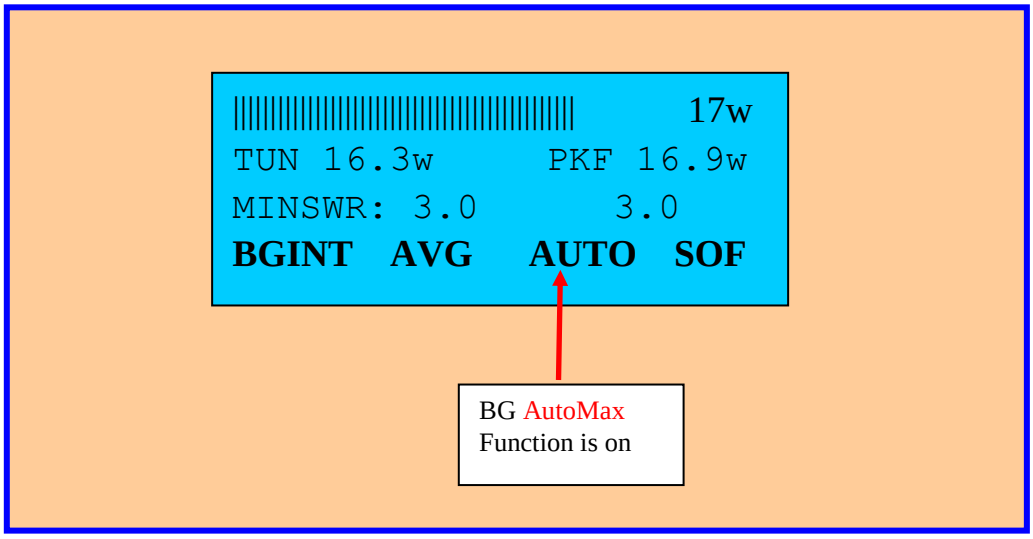
Menu Button 3 M3 controls the third field in the menu - the full scale value of the Bar Graph's manual range. When this field is set to AUTO, this indicates that the Bar Graph's **AutoMax** feature is ON. When the **AutoMax** feature is on, the software will dynamically adjust the Bar Graph's full scale value to the highest encountered power level. Press the M3 button repeatedly to turn off the **AutoMax** feature and cycle through the each of the Bar Graph's manual ranges.

Menu Button 4 M4 controls the fourth field in the menu - the Sticky Bar. Each push of M4 toggles the sticky bar on/off. In the above example, the sticky bar is **OFF**. Turn the sticky bar on and off to see its effect. (The sticky bar holds the highest bar graph segment for a programmable period of time). The sticky bar is not limited to peak measurements. It will hold the highest value of ***any parameter*** being displayed by the Bar Graph (as specified in the second menu option).

Bar Graph AutoMax Function: Since this feature dynamically modifies the full scale value of the Bar Graph to the largest encountered measurement value, the Bar Graph display will always provide maximum resolution without the possibility of a Bar Graph overrange condition. Since you have turned off the Bar Graph's **AutoMax** function above by selecting the various manual ranges, reactivate the Bar Graph's AutoMax mode by pushing the **AutMx** **shortcut** button (long push). You will receive a confirmation message on the LCD that the AutoMax function has been turned on. The menu line will then change as shown below with field 3 set to **AUTO.** The green LED on the shortcut button will also turn on to indicate that the AutoMax function is on.

Once the AutoMax function is on, you can reset its full scale value by pressing the **AutMx** **shortcut** button again (long push). This is useful, for example, if you have turned off your amplifier, are now operating barefoot, and want the AutoMax function to adapt to the new lower power level.

Bar Graph Menu with AutoMax Function On



2.9 Panel Meter Trim Pot Adjustment

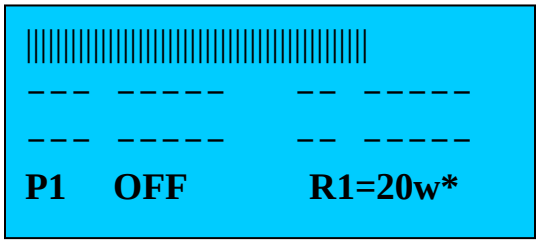
The panel meter calibration table for the internal crossneedle meter is loaded into the EEProm at the factory. However, before you can use the Panel Meter, you must adjust the **FWD** and **REF** trim pots on the left side of the meter case (the two trim pots labeled Crossneedle ***Meter – Internal***).

The description below describes a simple procedure for doing an initial adjustment of the trim pots that will get you close enough to the correct calibration so that you can proceed with the Quick Start walkthrough. At your convenience, you should run though the internal Panel Meter calibration steps described in section 8.6, which will give you an exact calibration.

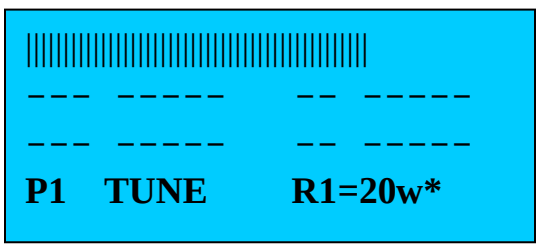
The initial Panel Meter trim pot adjustment is accomplished by utilizing the **Demo** feature. The Demo feature has a "full scale" mode, which causes the simulator to generate a full scale measurement equal to the full scale value of the current coupler. Virtual Coupler 5 should still be selected if you followed all of the steps in the walkthrough so far. This coupler has a default full scale value of 20 watts and a simulated default SWR value of 3.0. Therefore, when the Full Scale **DEMO** mode is used with this coupler, it will cause the software to generate an output to the FWD and REFL crossneedle ports that corresponds to full scale value of the FWD and REF scales (20 watts and 5 watts respectively). Once this is done, all that is required is to adjust the two trim pots for the internal panel meter so that both needles read full scale. As discussed above, do not be concerned if you cannot position the pointers exactly on the full scale values. Just get as close as possible using the trim pot adjustment so that you can continue with the walkthrough.

Detailed Steps for Initial Panel Meter Trim Pot Calibration:

1. The Panel Meter is turned off by default. You must first turn it on to perform the trim pot adjustments. Select the Panel Meter menu using the UP/DOWN buttons or by using the Panel Meter shortcut button. The Panel Meter menu will appear on line 4 as shown below.

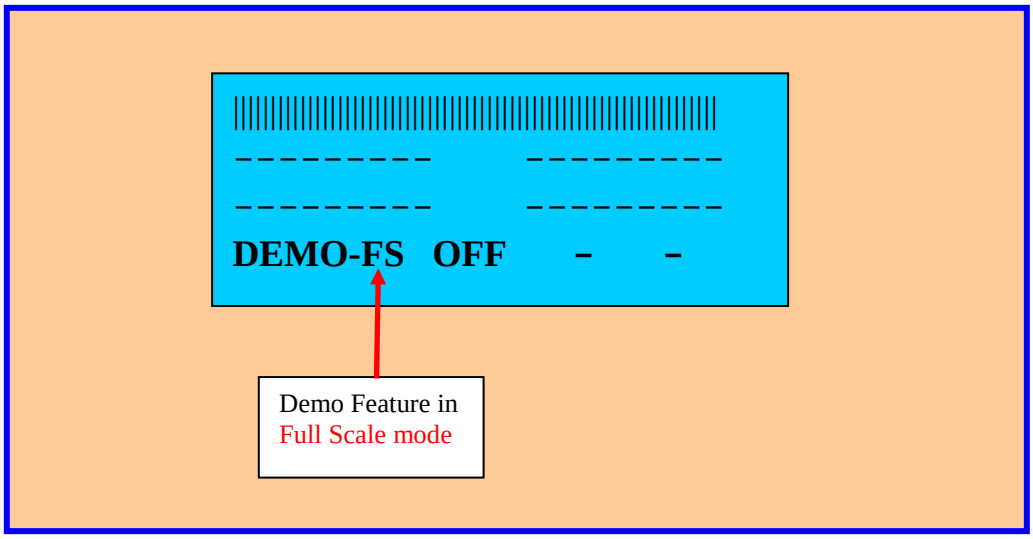


2. The above menu line indicates that the Panel Meter mode (shown in field 2) is "OFF". Turn the Panel Meter on by applying a short press to M2. This will set the Panel Meter measurement mode to **TUNE**. This is the mode you want since this mode displays the instantaneous power value, which drives both the FWD and REFL needles. The menu line will appear on line 4 as shown below.



3. The Panel Meter is now on. You now need to place the simulator in the F**ull Scale** mode. Select the **DEMO** mode menu on line 4 of the LCD using either the UP/DOWN buttons or the **DEMO** shortcut button. Then push M1 repeatedly until the **Full Scale** mode is selected, as shown below.

Demo Mode with Full Scale mode selected



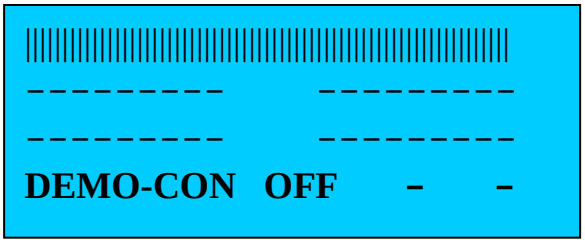
4. At this point, the software is driving the FWD and REF needle to their calibrated full scale values with a simulated SWR value of 3.0.

5. Adjust the FWD trim pot (Crossneedle Meter Internal) on the side panel until the FWD needle reads full scale (20). Get it as close as you can using the FWD trim pot. It does not have to be perfect at this point.

6. Adjust the REF trim pot (Crossneedle Meter Internal) on the side panel until the REF needle reads full scale (5). As with the FWD adjustment above, get it as close as you can using the REF trim pot.

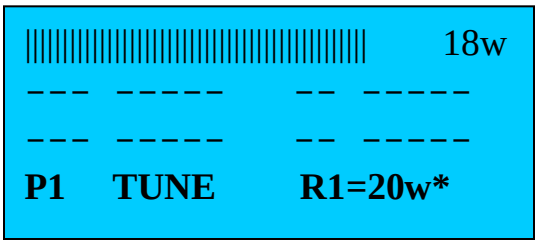
7. This completes the initial adjustment of the Panel Meter trim pots.

Before proceeding, place the simulator back into the **CON**stant mode by pressing M1 repeatedly. The menu will appear as shown below. At this point, the simulator will be generating a **CON**stant stream of pseudo random measurements upper bounded by the coupler's full scale vale (20 watts with a simulated SWR of 3.0 in this case). This is the mode we will use to proceed with the walkthrough.



At this point, save the settings to STARTUP Set.
Since you have made some additional changes, save the current meter settings again at this time with a long press to M1.

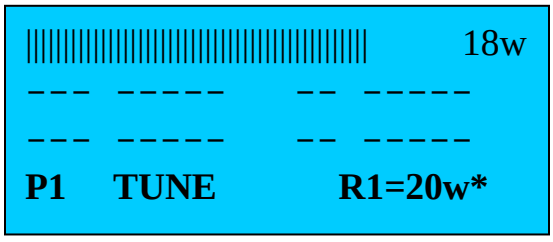
2.10 Using the Panel Meter



The Panel Meter menu has three menu fields, which are controlled by M1 – M3.

Menu Button 1 - M1 – Selects the Panel Meter (if you have more than one configured). Panel meter 1 selects the internal MB-1 crossneedle meter.

Menu Button 2 – M2 TUNE – Selects the item being displayed on the Panel Meter. Press the M2 button repeatedly (short presses) to cycle through the different display modes. The Demo mode should still be running. You will see the behavior of the Panel Meter change as you select different measurements to display. (***Note that the reflected needle of all crossneedle meters, whether using the internal crossneedle meter, or an external crossneedle meter, is active only when the instantaneous power mode (TUNE) is selected***. For all other measurement modes, only the FWD needle of a crossneedle meter will be active, and will display the selected mode (e.g., AVG, PEAK, etc.). Return the mode in **TUNE** as shown in the screen below.



Menu Button 3 – M3 R3 =20w* - Selects the Panel Meter's manual range. In the above example, the panel meter is in AutoRange mode (***this is indicated by the asterisk at the end of field 3***). The current full scale simulated measurement being generated by the simulator in this sample session is 20 watts (which corresponds to the first power range for the current panel meter, as set up during the Panel Meter calibration procedure described in section 8.6). Press the M3 button to turn off the Panel Meter's AutoRange function and to cycle the Panel Meter through its manual ranges (20w, 200w, 2000w). Set the range back to 20 before proceeding. (These ranges were programmed at the factory. When you perform calibration on external Panel Meters, you can set the ranges to any desired value).

Note that for this menu, there is no fourth menu item. Pushing M4 will result in an "INVALID BUTTON" error message being displayed on the LCD.

You can toggle the Panel Meter's AutoRange function on at any time with a long push of the **Autrng** shortcut button (bottom left switch). A confirmation message will be displayed on the LCD indicating that the AutoRange function has been turned on, and the green LED on that switch will light to confirm that the Panel Meter's AutoRange function is on.

2.11 Modifying a Panel Meter Parameter

We use the term ***setting*** and ***parameter*** to mean the following: A ***setting*** is an item that can be modified from the line 4 menu, such as the Panel Meter display mode, or range. On the other hand, a ***parameter*** controls another aspect of the meter that you will likely need to change less often, such as the Panel Meter's Peak Hold time. To modify a meter parameter, use the following procedure:

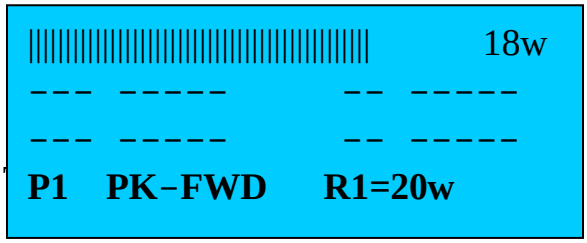
First bring up the applicable menu on line 4. Then press the setup button (long press on the **DISP/Set-Up** button, which is the top right button). The **DISP/Set-Up** button is a dual function button, and is shown in **Figure 10**.

The first function (DISPLAY) is activated with a ***short push*** of the **DISP/Set-Up** button and is used only to ***display*** the settings (in a read-only mode) of a meter function based on the menu currently being displayed on line 4 of the LCD. The second function (***Setup***) is activated with a ***long push*** of the **DISP/Set-Up** button and is used to enter the setup screen of a meter function based on the menu currently being displayed on line 4 of the LCD. ***You will use this procedure to modify a parameter***.

In this example, we will modify the Peak Hold time of the Panel Meter. But first, we will set up the Panel Meter to display peak power so that we can see the effect of changing the peak hold time.

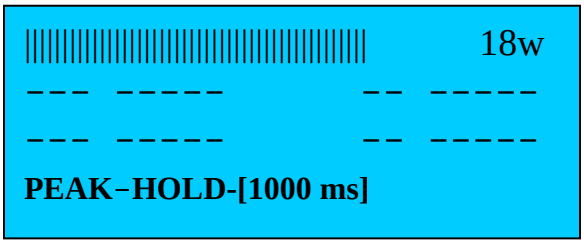
If the Panel Meter menu is not currently displayed on line 4 of the LCD, select it using the **PanMtr** shortcut button. Place the Panel Meter in the Peak display mode by pressing M2 repeatedly until **PK-FWD** is displayed in the second field of the menu as shown below. Also, if not already set at 20 watts, change the Panel Meter range to 20 watts by pressing menu button M3 repeatedly until R1=20w is displayed in field 3 of the menu line as shown below. At this point, the panel meter is displaying peak forward power. (Only the forward needle on the crossneedle meter operates in this mode).

The Demo mode should still be running. You should see the Panel Meter responding to the simulated measurements with its default peak hold time of 1 second.



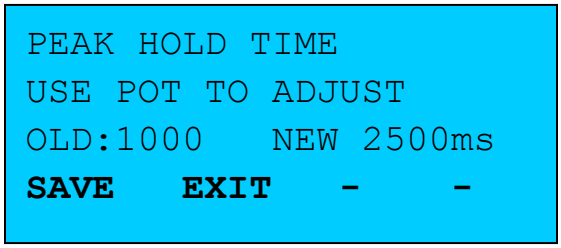
Bring up the Peak Hold Setup menu on line 4 using the UP or DOWN scroll buttons as shown below.

Peak Hold Menu



Now enter the Setup mode by pushing the **Set-Up** button (long push). Then follow the prompts on the LCD as shown below.

Setting a New Peak Hold Delay



In this example, you are prompted to adjust the front panel pot to select the desired delay. Adjust the front panel pot to select a peak hold time of 2500 ms. After selecting a new delay value with the pot, press M1, which corresponds to the **SAVE** option on the menu. This will save the new peak hold value and return the meter to normal operation. You should now be able to observe the longer peak hold time on the analog meter.

Many of the setup screens use the following convention: The **OLD** (current) value of a parameter is displayed along with the **NEW** value that is replacing it. For example:

OLD:1000 NEW 2500ms

In this case, the current peak hold value is 1000 ms, and the new peak hold value (once the **SAVE** button is pushed), will be 2500 ms.

Not all menus have a Setup function. If the Setup button is pushed and there is no setup function for the currently selected menu on line 4, the error message "**No Setup for Menu**" will be displayed on the LCD.

Before proceeding, set the Panel Meter measurement mode (field 2) to TUNE. Do this by selecting the Panel Meter menu on line 4, then pressing M2 until the Panel Meter measurement is set to **TUNE.**

2.12 Displaying Panel Meter Settings

The **DISP** button allows you to display information for the function associated with the currently displayed menu in a read-only mode, and eliminates the risk of inadvertently changing a setting when you only want to view the current settings.

The Display feature works similarly to the Setup function described above. First bring up the applicable menu, select the device if applicable (for example, the Panel Meter menu and Coupler menu allow you to select one of several Panel Meters and Couplers respectively). Then push the **DISP** button (short push) to display information for the device selected by the menu.

The example below shows how you would display the configurations settings for the Panel Meter 1 (which is the internal analog meter).

If the Panel Meter menu is not displayed on line 4, display it by pushing the **PanMtr** shortcut button. Then press the **DISP** button (short press) to display the Panel Meter settings. This will start to display the settings for the active Panel Meter as shown below:

First Page

```
MTR:1    SCALE:CROSS
NUMPWR SCALES= 3
```

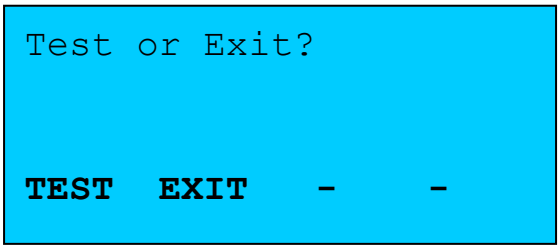
Second Page

```
Cross Needle FWD pwr
PWR RNG  1 = 20w
PWR RNG  2 = 200w
PWR RNG  3 = 2000w
```

Third Page

```
Cross Needle Rev pwr
PWR RNG  1 = 5w
PWR RNG  2 = 50w
PWR RNG  3 = 500w
```

Fourth Page



Some display functions, like the one above, have more than one LCD page of information. In this case, each push of the **DISP** button (short push) will advance to the next page of information. After all pages have been displayed, the meter will return to normal operation, or in some cases, give you a **TEST/EXIT** option on the line 4 menu as in this example. In these cases, use the M1 – M4 buttons to select the desired action. **EXIT** (M2) will return the meter to normal operation. **TEST** (M1) will perform a test function specific to the active menu. At this point, feel free to either **EXIT**, or to experiment with the **TEST** function. (The **TEST** function for the Panel Meter sequences the FWD and REF needles through each of their calibration points allowing you to validate the calibration.)

2.13 Panel Meter Calibration

Even though the Panel Meter calibration table is preloaded in EEPROM and should be relatively accurate, you will achieve maximum accuracy from the Panel Meter by recalibrating it at your convenience with the steps listed in section 8.6. The calibration procedure in section 8.6 will account for any sample to sample variations in the analog meter movement, and will give you much finer control in positioning the meter needles than could be achieved using just the trim pot adjustment.

2.14 Min/Max Functions

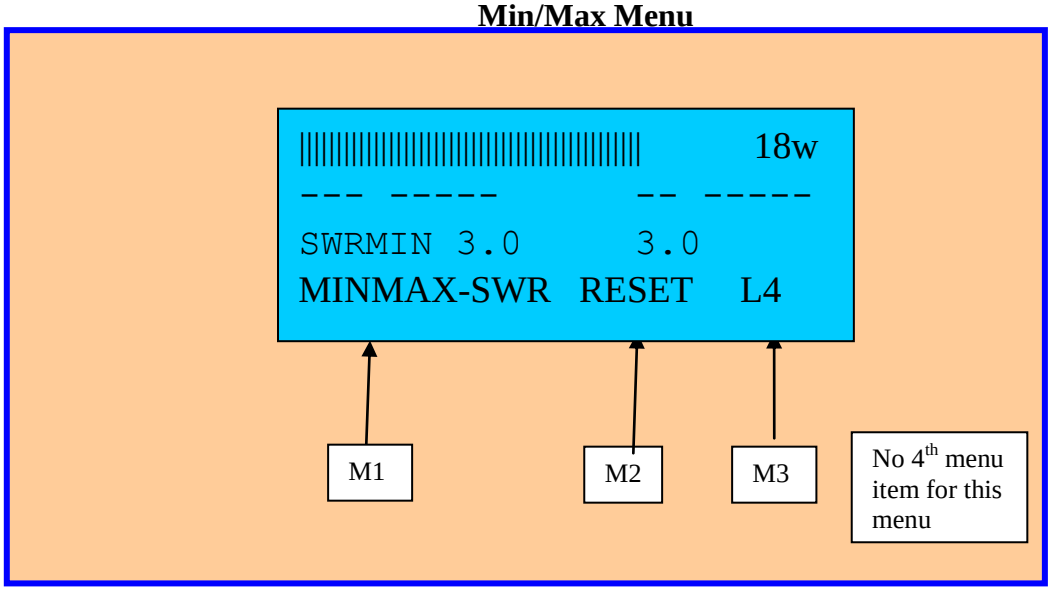
Function: When the Min/Max function is activated, it runs in the background and captures the minimum and maximum values of a specified measurement, such as SWR, Forward Power, etc. The measurements are captured and constantly updated, even if the Min/Max values are not currently being displayed on any of the display devices.

You may reset the minimum or maximum values at any time. The Min/Max values are also reset automatically by the software when you change certain key meter configurations that would invalidate the previous min and max values.

If you have not modified the LCD setting in the above example, line 3 of the LCD should still be displaying Min/Max values. If Min/Max values are not being displayed on line 3 of the LCD, activate the LCD menu first selecting the LCD menu by pressing the **LCD** shortcut button. Then use M3 to set line 3 of the LCD so that it is displaying MIN/MAX values.

Bring up the Min/Max menu on line 4 of the LCD using the UP or DOWN scroll buttons or by using the **MinMax** shortcut button.

Min/Max Menu



Menu Item 1 - M1 – selects the measurement type to be processed by the Min/Max function. Press M1 repeatedly to sequence through the different measurement types that can processed by the Min/Max function. You will see the Min/Max values for the selected measurement type displayed on line 3 of the LCD.

Press M1 until the Min/Max function is processing **SWR**. If the Demo mode is still running, and if you have not changed the default virtual coupler (Coupler 5), you will see that the Min and Max SWR values are both 3.0. This is because the currently selected coupler, virtual coupler 5, generates a constant simulated SWR (whose default value is 3.0).

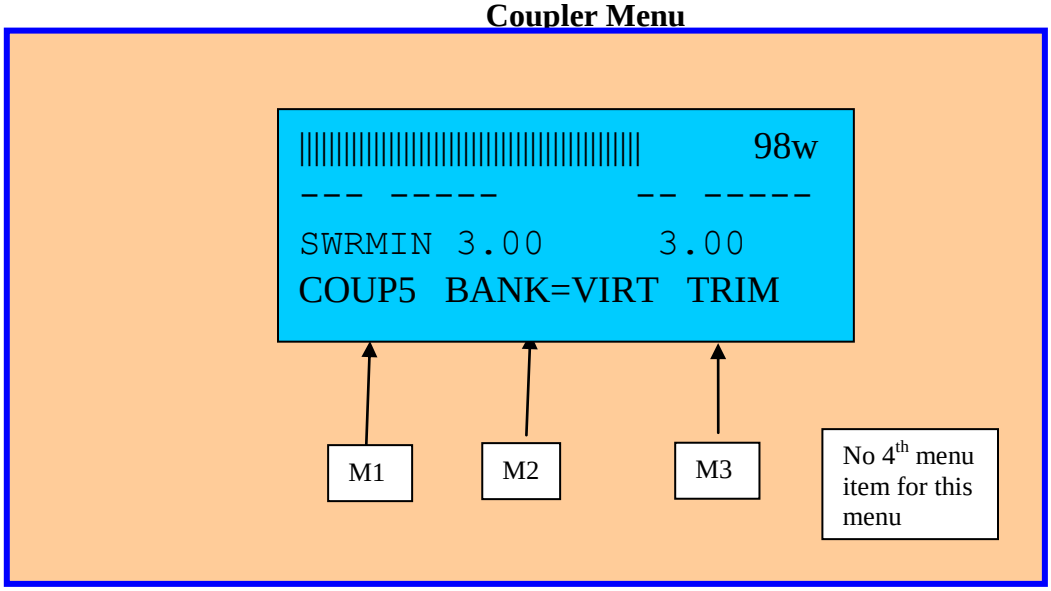
Now select virtual coupler 7. For coupler 7, the simulator ***generates a nominal SWR of 2.5 with a pseudo-random variation of 1 SWR unit***. Therefore default SWR values will be in the range 2.5 – 3.5. To do this, use the UP or DOWN scroll button, or use the **COUP** shortcut button to bring up the Coupler menu on line 4. This should appear as in the figure below.

Then press M1 repeatedly until coupler 7 is selected. ***You should now see the Min/Max values on line 3 vary between 2.5 (Min) and 3.5 (Max) since virtual coupler 7 generates a variable SWR in this range.*** Since the simulated measurements are generated with a random number generator, given enough time, the Min value should eventually bottom out at 2.5, and the Max value should eventually top out at 3.5.

Note - If you inadvertently overshot coupler 7 and advanced to coupler 8 (which is the RF Ammeter virtual coupler) by mistake, you will see LED and LCD display information associated with RF coupler related measurements turned off, such as SWR, Reflected power, and Delivered Power. This is done by design since these measurements have no meaning for an RF Ammeter. If this happens, simply press M1 repeatedly to advance the coupler number to the desired coupler – 7, and proceed.

Also note that the TRIM function shown in the third menu field below, applies only to real couplers (coupler 1 -4), and is therefore not applicable to this exercise, which is using a virtual coupler. The TRIM function is described in detail in section 3.8.2.

Coupler Menu

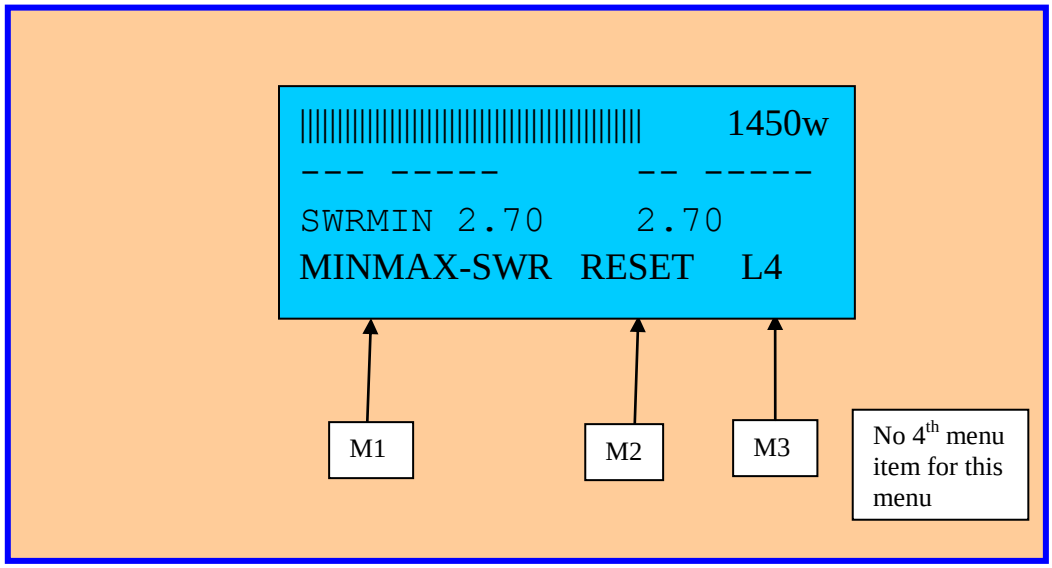


To Reset the Min-Max Values:

Bring up Min/Max menu on line 4 by pressing **MinMax** shortcut button. The menu line should appear as shown in the figure below.

Menu Button 2 M2 **– Resets both the Min and Max Values.** To reset the Min and Max values ***without the need to bring up the Min/Max menu***, apply a long press to the **Reset** shortcut button.

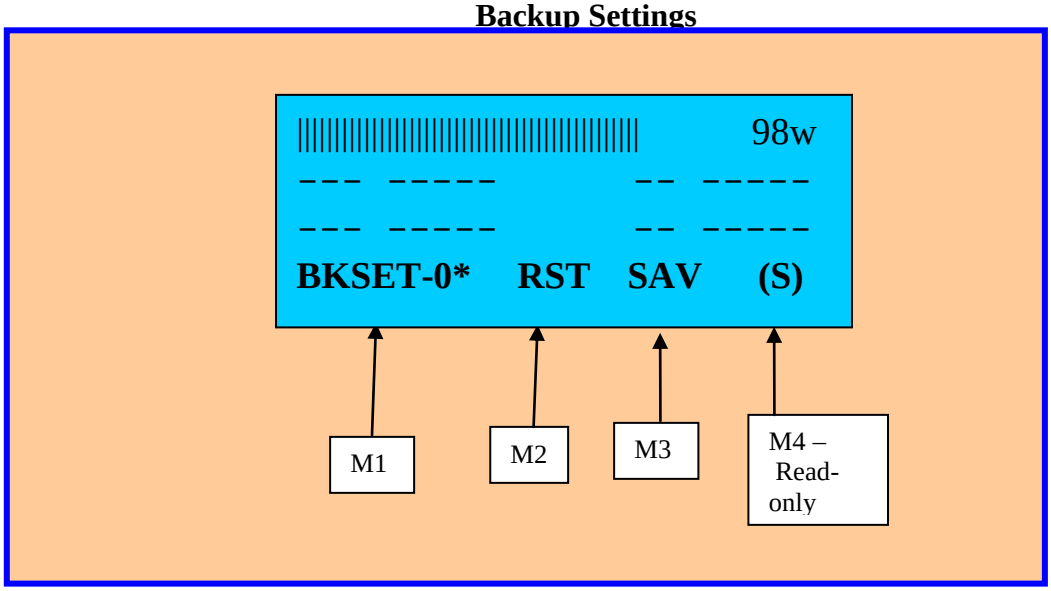
Resetting the Min/Max Values



2.15 Backup/Restore of Settings:

Once you have configured MB1 with your preferences, you can save all of the meter settings and parameters in a ***Configuration Set*** for later retrieval. We have already done this above using a special backup set, namely the ***Start-Up Backup set***. The menu for controlling Backup Settings is shown below. You can bring this menu up with a short push of the **Backup** shortcut button.

Backup Settings



There are seven configuration sets:
Startup set (also designated as BKSET-0) – The startup set will be restored each time the meter is powered up.

Configuration sets 1-5 – These are user-defined settings that must be explicitly saved and recalled using the above menu.

Default set – restores factory settings.

A full description of the Configuration Settings is given in section 3. But the following will get you started. At this point, simply save the current meter configuration to the Startup configuration set as done above by applying a long press to button (**M1**), which is also labeled as **SAVE** on the silkscreen. ***This will unconditionally save the current settings to the startup set, regardless of the menu that is being displayed on line 4.*** You will see a confirmation message displayed on the LCD confirming that the settings have been saved.

At this point, all of the modifications you have made so far in this walkthrough exercise are stored in EEProm, and will be automatically restored each time you power up the meter. Turn power off, and then back on. Verify that some of the changes you made, such as turning on seven segment modules D3 and D4, and the changes to the Peak Hold time were successfully saved and restored. The green LED is also lit on the **Backup** shortcut button when the meter is using the Startup set.

Note that the Demo mode is always turned off unconditionally at power-up or when a configuration set is restored, even if it was on when you did the backup. To restart the Demo mode, use the Demo shortcut button **DEMO** to bring up the Demo mode menu. Then press M1 to start the simulator.

Tip: Once you have configured the meter to your preference, save the settings in the Startup set as discussed above. It is also recommended that at the same time, you also save these settings to one of the five user-defined backup sets (e.g., B1). Later, if you should inadvertently make an error when making a change to the Startup set, you can always restore the previous (unaltered) startup set. In this example, you would do this by first restoring backup set B1 (which would be a copy of the previously saved Startup Set in this example). You would then save the "current meter settings" to the startup set. In effect, this approach provides a backup of your Startup set.

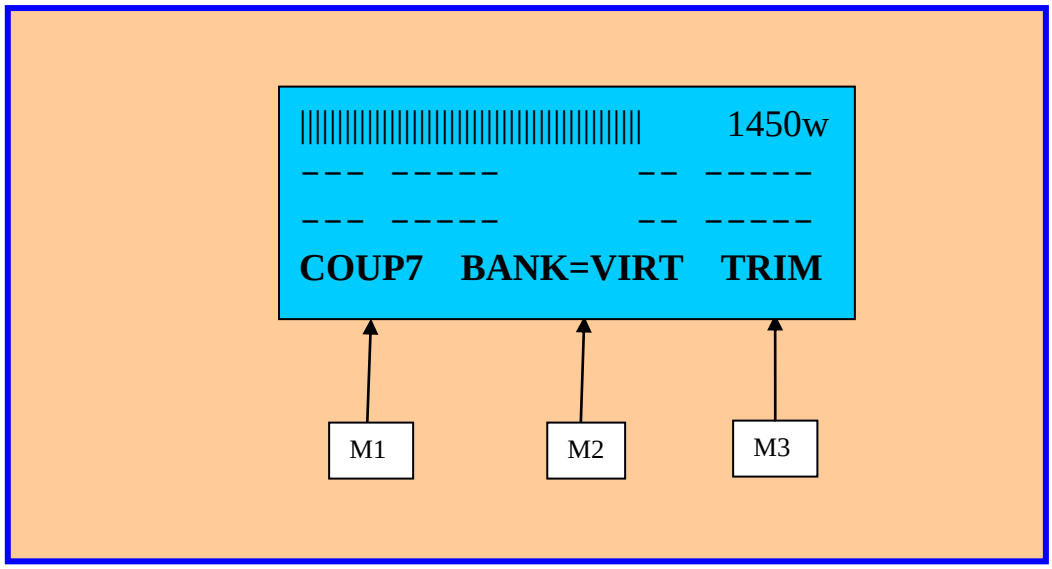
2.16 Demo Mode – More Details

The Demo mode feature can be a useful tool, especially if you connect additional analog meters to MB-1, since you can confirm that they are operating properly with the simulator before going live. This section provides some additional details on using the Demo mode feature.

MB-1 has ***four real coupler ports*** (couplers 1 – 4) and four ***virtual coupler ports*** (couplers 5 – 8). To select the bank of virtual couplers, first bring up the Coupler menu using the Coupler shortcut button **COUP**). The coupler menu will appear as shown in the figure below. If you still have coupler 7 selected, (which is a virtual coupler).

Each press of M2 ***toggles between the real bank of couplers (1 – 4) and virtual bank of couplers (5 – 8).*** A message will be displayed on line 1 of the LCD confirming the type of coupler bank (real or virtual) that was selected. (The yellow VirtCoup LED on the **COUP** shortcut button will be lit when the bank of virtual couplers is selected to remind you that a virtual (vs. real) coupler is selected.)

Coupler Menu



Each virtual coupler has its own default simulated full scale power value, simulated SWR value, and simulated Band Compensation Factors as per the table below:

Table 5 - Virtual Coupler Default Values

Virtual Coupler Number	Simulated Full Scale Power/Current	Simulated SWR	Simulated Band Compensation Factors		
5	20 watts	3.0	Band	Power	Compensation Factor
			6 Meters	5 watts	1.0740
			10 Meters	5 watts	1.0320
6	200 watts	2.0	Band	Power	Compensation Factor
			6 Meters	5 watts	1.0740
				50 watts	1.0840
				150 watts	1.0940
			10 Meters	5 watts	1.0320
				50 watts	1.0370
				150 watts	1.0420
7	2000 watts	Variable: 2.5-3.5	Band	Power	Compensation Factor
			6 Meters	5 watts	1.0740
				50 watts	1.0840
				150 watts	1.0940
				500 watts	1.1040
				1000 watts	1.1140
			10 Meters	5 watts	1.0320
				50 watts	1.0370
				150 watts	1.0420
				500 watts	1.0470
				1000 watts	1.0520
8 (RF Ammeter)	30 amps	NA			NA

The four virtual couplers can be reprogrammed to different power, SWR and full scale current values (RF ammeter) if desired. This is done by selecting the **DEMO** menu on line 4 of the LCD, and then pressing the **Set-Up** button (long push).

Virtual couplers 5 – 7 simulate power coupler type measurements. Virtual coupler 8 simulates an RF ammeter coupler. Virtual coupler 8 can also be used for testing Generic Meter Applications when using MB-1 with analog sensors. Select any of the RF power couplers (5 – 7) by pushing M1.

If the Demo mode is not currently on, turn it on. Do this by bringing up the **DEMO** menu using the **Demo** button. Then press M1. Press M1 repeatedly until the Demo mode **SWEEP** option is selected (**DEMO-SWP** in field 1 of the menu.) In the sweep mode, a linear sweep of simulated values is generated, starting at 0, and rising until the maximum full scale value of the current coupler (real or virtual) is reached. The value then resets and repeats the sweep cycle indefinitely.

This Demo mode is particularly useful for checking panel meter calibration. Since the sweep is linear, you should expect to see no discontinuities (jumps) as the panel meter needle sweeps through its range. If you see any "jumps", this means that you may have an error in the Panel Meter calibration. **Important: To check a panel meter using the Demo mode, make sure that the panel meter is set to the TUNE (instantaneous) mode. For example, if you select the average mode for display on the Panel Meter, the needle sweep will not be linear because of the averaging effect. Also make sure you have the Panel Meter's AutoRange function turned off and have the range set to match the full scale value of the coupler (20, 200, and 2000 for couplers 5, 6, and 7 respectively).**

Note that it is also possible to run the Demo mode when any of the real coupler ports (1 – 4) are selected. In this case, the full scale value generated by the Simulator will be the full scale value you specified when you calibrated the coupler. When running the Demo mode with a real coupler, a simulated SWR value of 3.0 is used.

The virtual couplers (5 – 8) are fully programmable. (See section 3 for more details). Note – when running your meter live, make sure the Demo mode is off. The yellow LED on the **Demo** button is lit as a reminder to let you know when the Demo mode is on.

2.17 Error Messages

If you push a menu button that is not valid for the current menu, ***or otherwise try to perform an operation that is not valid for the current meter configuration,*** one of the two error messages: "**INVALID BUTTON**" or "**INVALID OPERATION**" will be displayed on the LCD. For example, pushing menu button 4 (M4) for a menu that has only three menu items will generate the "**INVALID BUTTON**" error message. As another example, trying to bring up the BAND menu when the currently selected coupler is an RF Ammeter sensor or an analog sensor (Generic Meter application) will result in an "**INVALID OPERATION**" message, since the Band correction functions apply only to RF power couplers.

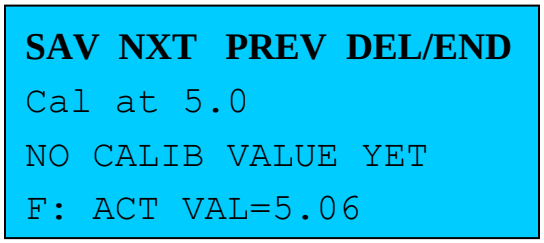
Error messages specific to each menu function are covered in the relevant menu descriptions in section 3.

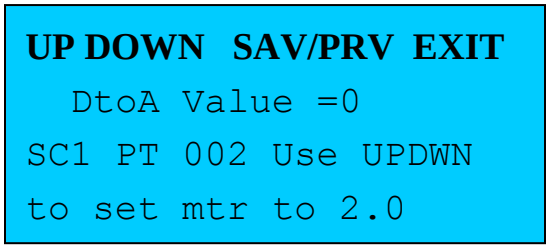
2.18 Conventions

SKIP Menu Option: Many of the **SETUP** screens have a **SKIP** option that when pressed, keeps the current setting, and advances you to the next setting. ***The SKIP button is always the third menu button*** M3 ***on all setup screens that offer a skip option.*** Keep this in mind when using the setup screens. This will allow you to quickly advance through multi-page setup menus using the SKIP option, to either quickly reach the parameter you want to change, or to quickly walk through all pages in a "read-only" mode.

SAVE and SELECT Menu Options: The words **SAVE** and **SELECT** are used interchangeably in various menus (i.e., on some menus, a SELECT option will be presented in place of a SAVE option). This was done to allow reuse of some common menus to save memory.

Menus with five options: There are only four menu buttons M1 – M4, but some of the menus have five option choices. Two examples are shown below, and are used in the setup screens for the Coupler calibration and Panel Meter calibration:





For these menus, two choices are combined (separated by a slash), and associated with a single menu button. When you encounter these menus, the first of these combined options is selected with a ***short push*** of the associated menu button. The second option is selected with a ***long push*** of the associated menu button.

The first of the two screens above is used during coupler calibration. You can see that there are two choices associated with M4. A short push of M4 will select the **DEL** option (deletes the current calibration point). A long push of M4 will select the **END** option (ends the current calibration session, and offers you the option to save the current session).

The second of the two screens above is used during Panel Meter calibration. There are two choices associated with M3. A short push of M3 selects the **SAV** option (saves the current calibration point). A long push of M3 selects the **PRV** choice (goes back to the previous calibration point in case you want to examine it or change it).

2.19 Summary:

Menus can be selected with the UP or DOWN scroll buttons. A long push on these buttons will cause the menus to scroll continuously until the button is released. Alternatively, the more

commonly used menus can be easily selected by a short or medium press of one of the Shortcut Menu Buttons, which are located on the bottom row of the front panel switches. Some of the shortcut buttons also have special operations for long pushes as well as LED indicators that display the status of key meter functions. A summary of the Shortcut buttons and LED indicators on the switches was given in **Table 3**.

To bring up the Set-up screens for a function, first bring up the related menu on line 4 of the LCD. Then press the Setup Button **Set-Up** (long push).

To display the current settings for a function in a read-only mode ***without the risk of inadvertently modifying them***, bring up the related menu on line 4 of the LCD. Then press the **DISP** button (short push). Press the **DISP** button again to sequence through multi-page displays.

Configuration settings can be easily saved and restored. A long push of the **BKUP** button ***restores*** the meter to the default settings. A long push of **SAVE** (M1) ***saves*** the current meter settings to the Startup Set regardless of the current menu being displayed on line 4. The startup set is restored each time the meter is powered up.

A button duration indicator (Green LED on switch **DOWN/Scroll** indicates when the short, medium, and long durations have elapsed when a button is pushed. This is useful for multifunction buttons that perform multiple functions based on the duration of the press.

2.20 Next Steps

At this point, we have covered most of the basics. Try experimenting using only Figure 2 (the Quick Start Guide of the Front Panel Switches). Change settings to see how they affect the meter. If you understand the operating principles discussed so far, things will be fairly intuitive. Don't worry about trashing the settings. A long push of the Backup Shortcut button **Default** will restore all settings to their default values. If you have saved your preferred settings to the startup set (accomplished with a long push of the **SAVE** (M1) button), and want to restore the startup settings, simply power cycle the meter. (Alternatively, a medium push of the Backup Shortcut button **StrtUp** will restore the Startup settings without having to power cycle the meter).

Section 3 provides a detailed description of each of the menus and related functions. This section is meant primarily as reference material.

The supplied MB-HF1 coupler should be connected to Coupler port 1 since the factory default settings have the coupler calibration table for this coupler loaded into the Coupler 1 table. Before you can use the coupler, you will have to adjust the side panel trim pots at a single power point for the FWD and REFL directions. This is discussed in section 6.

3 Menus - Detailed Description

This section describes each of the key meter functions indexed by menu. Each section includes the following information:

- A description of each menu
- A sample view of the menu and examples where appropriate.
- A description of the various menu options.
- Notes

The sections are listed in alphabetical order by menu name.

3.1 Alarm

Function: Controls the SWR alarm. When the SWR or user-defined low power or high power thresholds are exceeded, the meter will light a trip indication LED and will either activate the Alarm relay, provide an audible alert, or do both. The software also has an SWR warning function that is separate from the trip function. The warning function simply lights an LED (without latching) whenever the Warning SWR threshold is exceeded. The SWR Warning Feature and SWR Alarm feature are independent of each other and have independent thresholds.

In addition to setting the power and SWR thresholds, you can also define the interval that a low power or high power condition must be present for before the alarm activates.

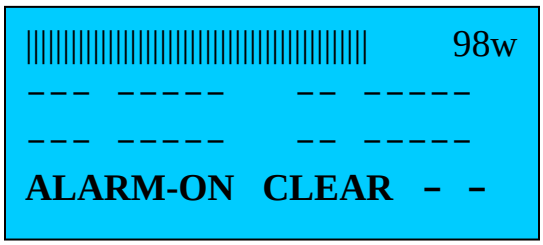
SNOOZE: The meter may be put into a Snooze mode. This will cause the meter to ignore any trip conditions during the "snooze interval". This is useful for temporarily disabling the trip detection software while tuning an antenna tuner or performing any operation where the SWR and/or power levels are likely to temporarily exceed the trip thresholds.

Auto Reset: The meter can be placed in an Auto Reset mode, which will cause any trip condition to be reset automatically after a user defined interval. If the fault condition still persists, the alarm function will trip again after the reset interval. This will happen indefinitely until the fault condition is corrected.

Conditional Auto Reset: The Conditional Auto Reset mode is similar to the Auto Reset mode described above, but in addition to the reset time criteria, this mode will only reset a trip condition if none of the monitored parameters exceed user defined thresholds.

To Activate Menu: Press the Alarm shortcut Button **Alarm**. The Alarm menu will be displayed on line 4 as shown below.

Alarm Menu



Example: ALARM-ON CLEAR - -

SWR Trip protection is **on** (enabled).

Field 1 – Turns Alarm protection on or off.

Choices:

ON – Alarm protection is enabled.
OFF – Alarm protection is off.

Field 2 – Short push resets any trip condition.

Notes:

Alarm Shortcut Button Functions:

Medium Push of **Clear** – **Resets** any trip condition.

Long Push of **Snooze** – Starts the snooze delay. Starting a snooze interval will automatically reset any trip condition as well.

LED Indicators on the Alarm Button:

- When Alarm protection is enabled, the Green LED is on.
- When the meter is in "snooze" mode, the yellow LED is on.

Other LED Indicators used for the Alarm Function:

The two LEDs on the **DOWN/Scroll** button (which is located directly above **Alarm** button) also provide alarm status as follows:

- When a Trip condition has occurred, the Red LED on the **DOWN/Scroll** button is on.
- When the SWR Warning threshold has been exceeded, the Yellow LED on the **DOWN/Scroll** button is on.

3.1.1 Displaying SWR Alarm Parameters

Function: Displays the current parameters for the Alarm features.

To Display Alarm Parameters: With the ***ALARM menu*** displayed on line 4 of the LCD, press the **DISP** button (short push). This will bring up the first page of ALARM settings. Keep pressing the Display button repeatedly (short pushes) to view subsequent pages and to exit the display mode, which will return the meter to normal operation.

Multi-page Display of Alarm Settings

SWR ALARM SETTINGS:
CUR DEVICE = RELAY
MIN VALID PWR=1.0w
TRIP DELAY=2000ms

CUR RESET MODE= AUTO
AUTO RESET INTERVAL= 3000ms
SNOOZE DEL=20 SECS

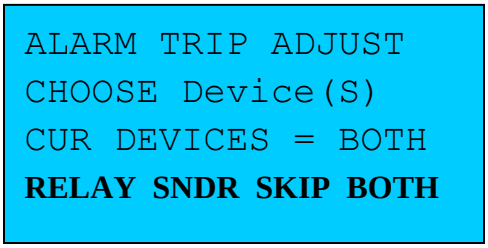
SWR TRIP=4.0
SWR WARN=3.0
MIN PWR= IGNORE
MAX PWR=IGNORE

3.1.2 Setting up the SWR Trip Protection Parameters

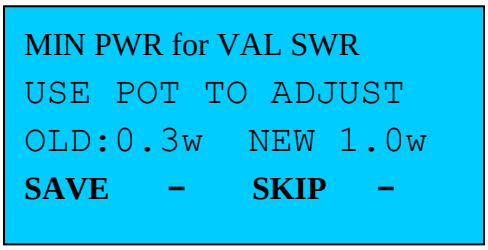
Function: Allows you to program the Alarm parameters.

To enter the Alarm Setup screen: With the ***ALARM menu*** displayed on line 4, press the Setup Button **Set-Up** (long press). This will bring up the first ALARM Setup screen as shown below. ***To keep an existing setting, hit SKIP M3.*** To change any of the settings, select the adjustment, using either the menu buttons M1 - M4, or by dialing in the new value with the front panel pot (e.g., SWR trip point is selected with the front panel pot). Then hit the SAVE menu button M1 to save the current selection. The software then advances to the next option, giving you a chance to change that option (or skip it (using M3) to keep the current value).

The first screen allows you to choose the device(s) that is activated when the alarm condition is detected.



The next screen allows you to choose the minimum power for which SWR values will be processed. Use the front panel pot to select the desired value.



The other alarm options are selected in a similar manner. The full set of options that can be controlled from the Alarm Setup screens is described below.

Alarm Trip Device – Sounder, Relay, or Both

Minimum Power for Valid SWR – Power less than this value will be ignored when calculating the SWR. Range: .1 watts – 10 watts.
The minimum power required for accurate SWR calculations is dependent on the coupler. Generally, the more sensitive the coupler, the lower the power required. If you are getting inaccurate SWR readings at low power levels, increase this setting. The default value for this setting is 1 watt.

Alarm Trip Reset

Manual – When Manual Trip Reset is chosen, the Alarm **Clear** button must be pressed to reset a trip condition.

AUTO – When AUTO Trip Reset is chosen, any trip condition will automatically clear after a user-defined preset time. An alarm tripped in this mode can be reset (overridden) with a manual reset.

COND – This option selects the "**COND**itional" AUTO Trip Reset mode. This mode is similar to the **AUTO** mode described above, but an alarm tripped in this mode only resets the trip condition ***if all fault conditions are no longer present after*** the auto reset interval expires. The main intent for this mode is for use with Generic applications. When this reset mode is selected, the absence of an audible alert or relay closure indicates that the measurement of interest is bounded by the lower and upper ranges of the user-defined fault thresholds.

The Conditional Auto Reset mode can be used with power measurements as well. When this mode is selected, you should be aware that if the alarm trips due to an SWR fault, and if the transmit power is turned off either manually or automatically (for example, if the relay contact is controlling a PTT function), ***the alarm will not clear until in in-range SWR measurement is subsequently obtained by reapplying power and obtaining an "in range" SWR reading.*** This is simply in keeping with the definition for this mode – namely the alarm condition will not clear until ***both*** a user time interval expires ***and*** no fault conditions are present.

Like to AUTO reset mode, an alarm tripped in this mode can be reset (overridden) with a manual reset.

Auto Reset Interval

If the Auto Alarm Trip Reset was chosen above, this setting specifies the auto reset interval (50 ms – 30 secs).

Trip Interval

The amount of time a low or high power condition must continually be present before the alarm trips (50 ms – 30 secs).

Snooze Delay

The amount of time alarm conditions will be ignored after activating the snooze delay (5 secs – 99 secs). Fault conditions that occur while the snooze delay is active will be ignored regardless of the reset mode (manual, AUTO, CONDitional).

SWR Trip Point

This establishes the SWR trip point.
SWR Trip Range: 1.1 – 9.9

SWR Warning Level

This establishes the SWR warning threshold. SWR levels exceeding this threshold will light the Hi SWR LED only. The LED will go off when the SWR value falls below the warning threshold. This setting has no affect on the alarm trip functions.
(SWR Warning Range: 1.1 – 9.9
To disable the SWR warning feature, select the IGNORE option from the menu (M2).

Min Power Trip Point

This establishes the low power trip point. Power levels below this threshold that are longer than the ***Trip Interval*** will cause a trip condition. If you do not wish to include low power criteria in the alarm trip function, set this to **IGNORE**.
Range: 1 watt – 27,500 watts

Max Power Trip Point

This establishes the high power trip point. Power levels above this threshold that are longer than the ***Trip Interval*** will cause a trip condition. If you do not wish to include high power criteria in the alarm trip function, set this to **IGNORE**.
Range: 1 watt – 30,000 watts

Notes: It is not valid to set all three trip thresholds (SWR Trip Point, Min Power Trip Point, and Max Power Trip Point) to **IGNORE.** At least one of these thresholds must be set to a numeric threshold.

3.1.3 Operating the Alarm Functions

To Enable/Disable the Alarm Function – activate the Alarm menu on line 4 of the LCD. Then press M1 to toggle alarm protection ON/OFF.

To Manually reset an alarm trip Condition – When an alarm trips, the TRIP LED will light. The sounder and/or the relay will also activate depending upon how you have configured the Alarm protection options. A medium push of the **Clear** button will clear the alarm.

Auto Reset of a Trip Condition – If the Auto Reset option is enabled, the alarm will automatically be cleared after the Auto Reset interval has elapsed. If the condition that triggered the alarm is still present, the trip/reset sequence will repeat indefinitely until the fault condition has been removed. You may override the auto reset with a manual reset if desired (with a medium press of the ALARM button.

Auto Reset of a Conditional Auto Reset Condition – Identical to the Auto Reset mode described above with the additional criteria that the reset will not occur until all of the alarm related measurement no longer exceed their fault thresholds.

Alarm Snooze – A long push of the **Snooze** button will place the alarm function in a snooze mode. This will cause the software to ignore any fault conditions until the snooze duration elapses. This is useful, for example, for setting your antenna tuner. The snooze timer can be restarted indefinitely by additional short pushes of the Relay Button. Activating the snooze interval also resets any current trip condition. The yellow SNOOZE LED is lit when the meter is in the snooze mode.

3.1.4 Alarm Error Messages

MAX MUST BE > MIN
When setting up the low power and high power trip points in the setup screens, the high power threshold must be greater than the low power threshold. If this rule is violated, this error message will be displayed, and the newly entered settings will be discarded. The current settings will be retained.

ALL SET PTS SET TO IGNORED –
When you set up the alarm parameters, you must specify at least one valid trip point parameter (either the SWR trip point, the low power trip point, or the high power trip point must be set to a numeric value). If this rule is violated (i.e., all three set points are set to "IGNORE"), this error message will be displayed, and the newly entered settings will be discarded. The current settings will be retained.

3.1.5 Using the Alarm Functions with Generic Meter and RF Ammeter Couplers

The Alarm functions can also be used with coupler ports configured as RF Ammeters and Generic Meter Applications. For these coupler types, the SWR alarm and warning thresholds are not meaningful and are therefore disabled by the software, but the **Min Power Trip Point** and **Max Power Trip Point** can be used to alarm the instantaneous value of the RF current (RF Ammeter applications) or the instantaneous value of the generic measurement (Generic Meter Applications). For example, assume you have connected one of the coupler ports to a temperature sensor, and that you can have configured that coupler port as a Generic Meter to measure temperature (See Generic Meter User's Manual). If the low power and high trip points have been set to 40 and 90 respectively, an alarm will be tripped if the temperature makes an excursion outside of that range. As with power couplers, both the audible alarm and relay are available based on how you have configured the alarm options.

Notes:
Normally, you will not use thresholds selected for use with a power meter application for RF Ammeter or Generic Meter trip applications. This is one of the places where the MB-1 configuration sets come in handy. You can set up a configuration set to select an RF Ammeter coupler or Generic Meter application, and define the associated trip thresholds in that configuration set. By using this approach, simply selecting the desired configuration set keeps everything in synch.

If ***both*** the **Min Power Trip Point** and **Max Power Trip Point** thresholds are set to **IGNORE** when an RF Ammeter or Generic Meter application is selected, ***a trip condition will never occur since the SWR threshold is ignored in these cases***. You must have at least one of these two thresholds set for use with an RF Ammeter of Generic Meter application.

3.2 Averaging Filter

Function: The first item in this menu is used to bring up the Averaging setup screen, allowing you to select the averaging window used for computing Average measurements. (You can use the Set-up button as well). The averaging function may be used with all coupler types (power, RF ammeter, Generic Meter Applications).

The second item in this menu offers you the option to turn the Steady State (constant) signal indicator on or off. The third item in this menu offers you the option to turn the "SWR Changing" Indicator on or off. These two items are discussed below

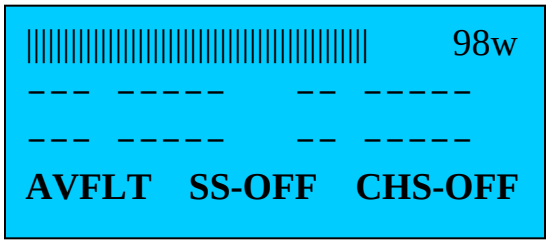
In addition to setting the averaging window, this setup screen also allows you to snap (lock) the average measurement ***to what would have been its final value*** when a steady state (constant) signal is detected. An example is useful to explain how you might use this feature.

Assume that you have configured the meter to display average power on one of the display devices such as the analog meter. Assume further that the averaging window has been set to a relatively long window (e.g., 8 seconds). If you place your equipment in a tune mode with a constant signal, each time you key the transmitter, it will take approximately 8 seconds for the average measurement to reach its final value on the analog meter. If you have the snap feature on, as soon as the software detects a constant signal, it will start a user specified timer, and after that timer elapses, the average value will lock or "snap" the average measurement to the current steady state level. This allows you benefit from the advantages of displaying average power for normal time varying signals, such as SSB, while giving you a quick stable response to a constant signal, as would be encountered during tune-up.

This could be particularly useful if you have remotely placed an analog meter next to one of your stations. Since you can only display one parameter at a time on an analog meter, choosing to display the average value with the snap feature provides you with the advantages discussed above. You can turn the snap feature off completely if desired.

To Activate Menu: Press the UP or DOWN menu buttons until the Averaging Filter Menu is displayed on line 4 as shown below.

Averaging Filter Menu



Example: AVG-FLT SS-OFF CHS-OFF

Field 1 – Averaging Filter

Choices:

There are no choices for this field. The only purpose of this menu item is to launch a setup screen for the averaging parameters by pressing M1 or using the **Set-Up** button.

Field 2 – Determines whether the Steady State (constant signal) indicator is on. This indicator, when lit, essentially indicates that the incoming signal is constant.

Regardless of the on-off state of this feature, ***the Steady State signal indicator is unconditionally enabled during the procedure for adjusting the side panel Reflected Channel trim pot of a power coupler during the calibration procedure*** (see section 6).

Since MB-1 can also be used to implement a variety of Generic applications, the full range of those applications cannot be predicted. Therefore, we thought that there might be some value to allowing the user to activate this indicator for uses other than reflected channel calibration. What is happening in the software with respect to this feature is as follows. The digital filters use different parameters based on whether the incident signal is approximately constant or is time varying. The green LED on M1 is lit when the digital filters have declared the signal to be (approximately) constant. The LED is off otherwise. You can toggle this feature on/off by pressing M2. The default setting for this option is OFF.

Choices:

SS-ON – Steady Sate (constant signal) indicator is on
SS-OFF – Steady Sate (constant signal) indicator is off

Field 3 – Determines whether the "**SWR Changing**" Indicator is on. When activated, the green LED on the **DISP/Set-Up** button will illuminate when the SWR value has changed and the SWR filters are in the process of acquiring the new SWR value. You can toggle this feature on/off by pressing M3. This was a development tool that we decided to keep in the product. While probably of limited value to an end user, we left this feature in and set the default for this option is OFF. Feel free to experiment with it if you are curious about how it works.

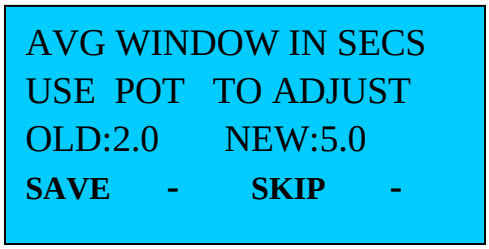
Choices:

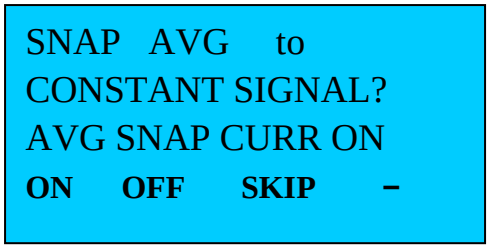
CHS-ON – "SWR Changing" (Acquiring New SWR) indicator is on
CHS-OFF – "SWR Changing" (Acquiring New SWR) indicator is off

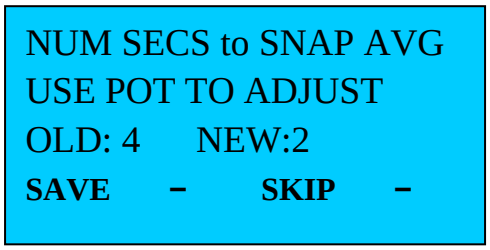
3.2.1 Setting up the Averaging Filter Parameters

To enter Setup: With the ***Averaging Filter menu*** displayed on line 4, either press M1 or the Setup Button **Set-Up**. This will bring up the setup screens shown below.

Averaging Filter Setup







The full set of options that can be controlled from the Averaging Filter Setup screens is given below.

Averaging Window in Seconds: -

This controls the duration of the sliding window of the averaging filter (.3 seconds – 8 seconds).

Snap Average to Constant Signal: -

When activated, if a constant signal is detected, the average measurement will snap (lock) to the constant value after a time period specified by the next parameter. ***This feature can be used for RF Ammeter and Generic Meter applications as well***.

Number of Seconds to SNAP Average: -

If the SNAP option described above is enabled, this parameter specifies the time interval the incident signal must be declared to be a steady state signal before the average measurement snaps to the steady state value. If the SNAP option defined above is set to **OFF**, this option is skipped in the setup screens.

.

3.2.2 Displaying the Averaging Filter Parameters

To view the averaging filter parameters without making any modifications, bring up the Averaging Filter menu on line 4. Then press **DISP**. The display will look similar to that below.

Display of Averaging Filter Parameters

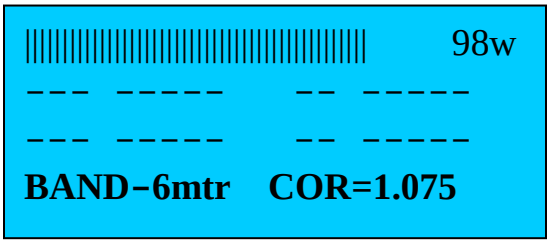
```
AVG WINDOW=5.0 SECS
AVG SNAP CURR ON
TIME TO SNAP=2 SECS
```

3.3 Band Selection

Function: Selects the band and applies real time band correction factors based on the instantaneous power level. To use this feature, you must have previously performed frequency correction while calibrating the currently selected coupler.

To Activate Menu: Press the Band shortcut Button **BAND**.

Band Menu



Example: BAND-6mtrs COR=1.075
Correction factors for the 6 meter band have been selected.

The current correction factor (function of the current power) is 1.075 with respect to the calibration data of the reference band.

Field 1 – Band

Choices:

70 cm
2 meters
6 meters
10 meters
12 meters
15 meters
17 meters
20 meters
30 meters
40 meters
60 meters
80 meters
160 meters

Note: Only those bands that have been compensated during coupler calibration can be selected (the others will be skipped). Of course the reference band can always be used for operation on all bands even if they have not been compensated during calibration.

Field 2 – Real Time Correction Factor – displays real time correction factor, which is a function of the power levels at which band correction was performed, and the instantaneous power currently being measured.

Choices:

SHOW – Displays the correction factors in real time
REF-BAND – This text is displayed when the reference band is selected, since no correction is applied at the reference band.

Example: BAND-6mtr COR=1.075 – The 6 meter band is selected. The instantaneous correction factor being applied to the current band based on the current power level is 1.075. If the band correction has not been performed on the coupler, "**NOT-CALIB**" will be displayed in place of the correction factor.

A more detailed discussion of band compensation is given in the **Simulated Band Compensation Factors** in section 3.10, which discusses how band compensation works.

3.3.1 Displaying the Band Correction Factors

Function: Displays the Coupler settings and Band Correction settings.

To view the band correction settings, select the Band menu. Then press **DISP**. ***This activates the same display screens as the Coupler information display screens*** (which include the band correction information as well as the Reference band calibration information).

Notes:

1. The Band menu and its functions are not valid for RF Ammeter Couplers and Generic couplers. An attempt to select the BAND menu when an RF Ammeter or Generic Coupler is selected will result in an error message.

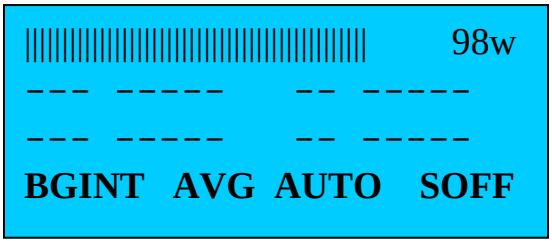
2. Whenever you switch to a different coupler, the band will default to the reference band for that coupler.

3.4 Bar Graph

Function: Controls the bar graph functions.

To Activate Menu: Press the Bar Graph shortcut Button **BarGr** button.

Bar Graph Menu



Example: **BGINT -** Bar Graph is set to **INT**ernal device (LCD)

AVG – Bar Graph is displaying Average Power

AUTO – Bar Graph is set to AutoMax mode (dynamic full scale adjustment)

SOFF – Bar Graph Sticky bar (peak hold segment) is off

Field 1 – Bar Graph Devices

Choices:

BGINT – Internal Bar Graph only (Line 1 of LCD)
BGEXT – External Bar Graph only (connected to rear panel connector)
BGBTH – Both Internal and External Bar Graph Devices are active
BGOFF – Bar Graph is completely turned off (disabled)

Field 2 – Selects the measurement value to display on the Bar Graph.

Choices:

OFF – Turn off Bar Graph display

TUNE – Instantaneous FWD power

AVG - Average FWD power

PK-F or **PK-D** – Peak Forward power or Peak delivered power (FWD – REFL). The Peak Forward or Peak Delivered selection is made globally for all peak power measurements in the **LCD** menu.

REFL – Reflected power

DELV – Delivered (FWD – REFL) power

SWR - Computed SWR value

MIN-MAX Parameters – the parameter being processed by the Min/Max function is selected with the Min/Max menu (see section 3.13). The following shows the mapping for the displayed tags associated MIN function. The mapping for the MAX function is the same, with **MAX** replacing **MIN**.

MIN**S** – Minimum SWR
MIN**T** – Minimum Instantaneous (TUNE) Power
MIN**F** – Minimum (TUNE) Power with filtering
(See notes in section 3.13)

MIN**A** – Minimum Average Power
MIN**P** – Minimum Peak Power
MIN**R** – Minimum Reflected Power
MIN**D** – Minimum Delivered Power
MIN**O** – Min/Max function is off

Note: PK-DEL, **REFL**, **DEL, SWR** are not valid selections for RF ammeter couplers or Generic Meter applications, and are skipped automatically by the software when an RF Ammeter coupler or Generic Meter coupler is selected.

Field 3 – AutoMax indicator or manual range. Pressing M3 will turn the AutoMax function off if it is on. Each press of M3 will advance through the manual bar graph ranges.

Choices:

AUTO – AutoMax is currently on. (AutoMax can be turned on only by using the **AutoMx** button, as described below).

P1 – P5 – Up to five Bar Graph power ranges for power measurements – user configurable

S1 – S3 – Up to three Bar Graph SWR ranges for SWR measurements – user configurable

The following are the default Power and SWR ranges:

Table 6 - Bar Graph Default Manual Ranges

Range	Full Scale
Power	
Range 1	20 watts
Range 2	50 watts
Range 3	100 watts
Range 4	200 watts
Range 5	2000 watts
SWR	
Range 1	3.0
Range 2	5.0
Range 3	10.0

Note – When an RF Ammeter or Generic Meter coupler is selected, only the power scales are available for selection. (SWR is not valid for these applications).

Field 4 – Sticky bar

Choices:

SON – sticky bar on

SOFF – sticky bar off (**SOF** is displayed instead of **SOFF** when a numerical (vs. **AutoMax**) range is selected to allow for longer field 3 values).

Note: The sticky bar can be used with ***any*** type of bar graph measurement.

Bar Graph Shortcut Button Functions

Long Push of **AutoMx -** will place the Bar Graph in the AutoMax mode (if not already in that mode), and will reset the full scale value of the AutoMax feature. If the AutoMax function is already activated, each long push of this button just resets the full scale value of the AutoMax function without altering its on or off state. This is useful if you switch, for example from an amplifier to barefoot operation, and want the bar graph to adapt ***down*** to the lower barefoot power.

Notes: The AutoMax function is not allowed when the measurement being displayed on the Bar Graph is ***either SWR, or the Max function*** (with any parameter). SWR is excluded to prevent a situation where a reasonable SWR and a large SWR could not be easily distinguished, since, in AutoMax mode, both would generate a full scale reading on the bar graph.

The "Max" function is excluded for use with the AutoMax feature because the Bar Graph display would ***always be full scale and never change*** (since, when AutoMax is on, the Bar Graph's full scale value adapts to the maximum value, ***which, by definition, is identical in value to the Max Value being displayed***). It would have been valid to allow the AutoMax function when the Max value is being displayed, but you may have found it confusing since the bar graph would always be at full scale and would never change.

Therefore, if the Bar Graph AutoMax function is turned on, and if you select SWR or the Max function for display on the Bar Graph (field 2), the software will turn the AutoMax function off.

Since the AutoMax function is not valid for SWR, if SWR is being displayed on the Bar Graph, the software will turn the AutoMax feature off (if it is on), and will select the lowest manual Bar Graph scale for SWR.

If the AutoMax feature is on and the Max function is selected for display on the Bar Graph, the software will select the largest manual scale. This provides the highest likelihood of an in-range reading for the Max function. Of course, you can then select any manual range you want.

For the same reason, if an attempt is made to turn the Bar Graph's AutoMax function on when either SWR or the Max function is currently being displayed on the Bar Graph, the operation will be denied, and an "INVALID OPERATION" message will be displayed on the LCD.

If the AutoMax function was turned off by the software, as described above, because the SWR or the Max function was selected, the software will automatically turn the AutoMax mode back on if the user later changes the Bar Graph to display a parameter for which the AutoMax function is valid (any functions except SWR and the Max function).

Whenever you change couplers, the Bar Graph display mode, etc, it is recommended that you reset the AutoMax full scale value with a long push of the **AutoMx** button.

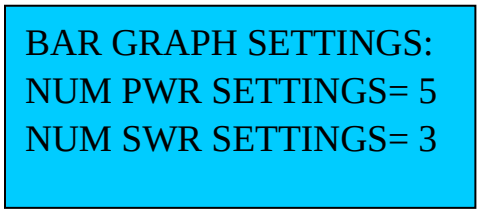
The above notes may seem a bit confusing, but the software should automatically switch modes to make the most sense for the exceptions noted above. We just wanted to list the rules for completeness.

3.4.1 Displaying the Bar Graph Manual Ranges

Function: Displays the Bar Graph manual power and SWR ranges.

To view the current Bar Graph manual range settings, select the Bar Graph menu. Then Press **DISP**. The Bar graph ranges are then displayed. Keep pressing **DISP** (short press) to advance through additional screens. A sample is shown below:

Display of Bar Graph Manual Ranges



PWR RNG 1 = 20 w
PWR RNG 2 = 50 w
PWR RNG 3 = 100 w
PWR RNG 4 = 200 w

•
•
•

SWR RNG 1 = 3.0
SWR RNG 2 = 5.0
SWR RNG 3 = 10.0

3.4.2 Programming the Bar Graph Manual Ranges

Function: Allows you to program the bar graph manual ranges if the default values do not meet your needs.

Setup Screens for Bar Graph Manual Ranges

SET BAR GRAPH POWER
RANGE 1 USING POT.
OLD:20 NEW:50
SAVE DONE SKIP –

•
•
•

SET BAR GRAPH SWR
RANGE 2 USING POT.
OLD:NTSET NEW 4.0
SAVE DONE SKIP –

To enter Setup: With the ***Bar Graph menu*** displayed, apply a long push to the **Set-Up** button. This will bring up the Bar Graph setup screen. ***To keep an existing setting, hit SKIP*** M3**.** This will advance you to the next option giving you a chance to change its value. To change any of the settings, dial in the new value with the front panel pot. Then hit the SAVE M1 menu button. You can program less than five power ranges and less than three SWR ranges if desired. Do this by hitting the DONE M2 menu button. For example, to save two power settings and one SWR setting, first select the two power settings using the pot and SAVE button as previously described. ***After entering the two power levels, since you are now done setting the power levels, press the DONE button.*** This will skip the remaining power levels and advance you immediately to the SWR settings screen. Select a single SWR value, and then hit SAV. You are now done saving the SWR settings. ***Press the DONE button***. This saves the new values, and exits the setup menu.

Each power range may be set from 1 watt to 30,000 watts.
Each SWR range may be set from 2.0 to 50.0.

NOTES: If a value of **NTSET** (not set) is displayed during setup, as shown above in one of the sample screens, this indicates that the current parameter is currently not set (as would happen, for example, when displaying the setup screen for the second SWR range when you had previously set up only one SWR range, as explained above).

3.4.3 Bar Graph Error Messages

INVALID OPERATION– the Bar Graph's AutoMax Bar function is not applicable for SWR measurements (including SWR-Min/Max functions). It is also not valid for any Max function. An attempt to turn the Bar Graph AutoMax function on when the Bar Graph is displaying one of these modes will result in this error message.

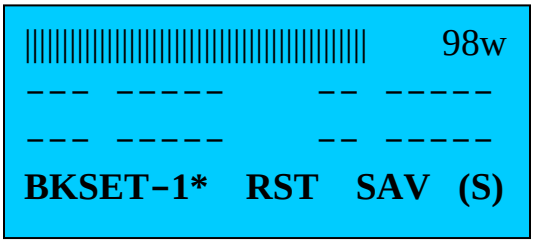
3.5 Backup (Configuration) Settings

Function: Saves or restores a set of configuration settings to/from EEProm. This feature allows you to configure the meter in a number of different configurations, each of which can be saved and restored with the push of a button. Seven configuration sets are supported including the factory default set.

This feature should not be confused with the PC-based backup/restore capability, which allows the EEProm image to be backed up to a PC file (this is described in section 3.11).

To Activate Menu: Press the Backup Settings shortcut Button **Backup**. This brings up the Backup menu on line 4 as shown below.

Backup Set Menu



Example: BKSET-1* SAV RST (S)
The current backup set that will be acted upon (saved to or retrieved from) is backup set 1. The asterisk in the first field indicates that backup set has been previously saved (and therefore, the meter settings may be restored from that set). ***The last field (field 4) is for display purposes only***, and indicates the active configuration set that is currently loaded into the meter (**S** = **S**tartup set is in effect in this example).

Field 1 – Backup Set that will be used for **SAVE** or **RESTORE** operations.

Choices:

D – Factory default set
0 – Startup set – Restored each time meter is powered on.
1 – 5 – User Defined sets

If an asterisk (*****) is displayed after the backup set number, this indicates that data has been saved to that set, and therefore, the meter settings may be restored from that set if desired.

Field 2 – **Restore** – Push this button to restore the configuration set identified in menu field 1. All seven configuration sets are valid for this button.

Field 3 – **Save -** Push this button to save all of the current meter settings to the configuration set identified in menu field 1. Settings are saved in EEProm for later retrieval. The current meter state can be saved to all configuration sets ***except the default set.***

Field 4 – Shows the ***currently active*** configuration set (***this field is for display purposes only*** – pushing M4 will generate an error message, and otherwise has no effect).

Possible Values:

D – Factory default set
S – Startup set
1 – 5 – User Defined sets

Backup Shortcut Button Functions:

***Medium Push* of StrtUp –** Restores the Startup set, if previously saved, without having to power cycle the meter.

***Long Push* of Default** -Restores the Default set.
.

LED Indicator on the Backup Shortcut Button:

This LED is lit when the ***Startup configuration set*** is loaded into the meter.

3.5.1 Backup/Restore Error Messages

"INVALID BUTTON" – The Default set cannot be modified (saved). An attempt to write (**SAVE**) the current meter configuration settings into the Default set (i.e., when field 1 is set to **D**) will result in this error message.

Notes:
Start-up Set: When you load a backup set into the meter using the restore option, including the default set, and ***if you want those settings to also be used as the startup set***, you must save those restored settings to the Start-up set by applying a long press to the **M1** button.

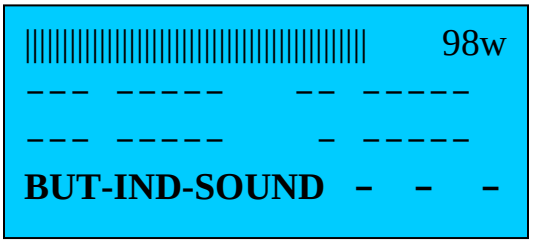
Alarm Operation: If the configuration set is changed while the alarm is tripped, and if the ALARM is **off** in the newly selected configuration set, the alarm will not be reset automatically. The alarm must be reset manually in this case. This ensures that the occurrence of an alarm event must be acknowledged by the user.

3.6 Button Push Indicator

Function: Controls the type of indication (audible beep or LED flash) that the user receives when pushing a button. As discussed above, most of the front panel switches have multiple functions depending upon the duration each button is pushed. This menu determines the type of indication that you will receives when a button is initially pushed; when the medium push interval elapses; and when the long push interval elapses, thereby providing a positive indication of the duration. This will allow you to reliably operate the front panel switches.

To Activate Menu: Press the UP or DOWN menu button until the ***Button Push Indicator menu*** is displayed as shown below.

Button Push Indicator Menu



Example: BUT-IND-SOUND - - -
Button push indicator will emit a sound when a button is initially pushed, or when the medium or long push interval elapses.

Field 1 – Button Push Indicator

Choices:

Sound – Audible beep is generated at each interval
LED – The green LED on the **Down/Scroll** button (top left button) flashes at each interval transition.
OFF - No special indication is given

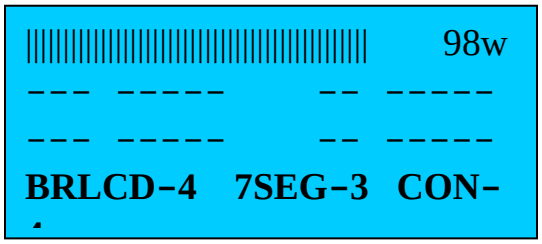
Notes: Audible Error Indication: When the Sound option is selected with this menu, in addition to generating a short "beep" on the initial push, and when the medium and long intervals elapse, three short beeps will be emitted when a user error is detected, such as when an illegal selection has been attempted with one of the four menu switches. This is in addition to the error messages that are displayed on the LCD.

3.7 Brightness/Contrast

Function: Controls the brightness of the LCD display and internal 7-segment displays. Also controls the contrast of the LCD display.

To Activate Menu: Press the UP or DOWN menu buttons until the Brightness Menu is displayed as shown below.

Brightness Menu



Example: BRLCD-4 7SEG-3 CON-4
LCD brightness is set to level 4.
Brightness of internal 7-segment devices is set to level 3.
LCD contrast is set to level 4.

Field 1 – LCD Brightness
Choices: 1 - 9

Field 2 – 7 Segment Display Brightness (controls the brightness of the internal 7-segment devices only)
Choices: 1 - 9

Field 3 – LCD Contrast
Choices: 1 - 9

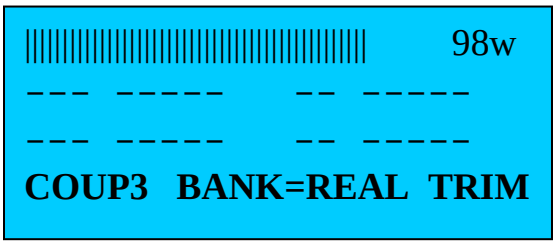
Notes: You may find that changing the LCD contrast produces subtle changes in the apparent contrast. However, you will find that adjustment of the contrast value affects the persistence of the characters on the LCD as the display changes. If you set the numeric display update rate to a high value, and if you modify the contrast settings while the display is active, you will see this effect. A setting of 5 provides good results in most cases.

3.8 Coupler Selection

Function: Selects the coupler or other input device (RF Ammeter, Generic Meter Application Input). Also used for selecting a one of the four virtual couplers for use with the simulator.

To Activate Menu: Press the Coupler shortcut Button **COUP**. The coupler menu will be displayed on line 4 as shown below.

Coupler Menu



Example: COUP3 TYPE=REAL TRIM

Coupler 3 is selected. The real (vs. virtual) bank of couplers is selected.

Field 1 – Displays the selected coupler port.

Choices:

1 - 4 (when the Real Coupler Bank is selected)

5 - 8 (when the Virtual Coupler Bank is selected)

Field 2 – Displays the type of coupler bank that is currently selected (real or virtual)

Choices:

Real Coupler Bank selected (Couplers 1 – 4)

Virtual Coupler Bank selected (Couplers 5 – 8)

Field 3 – Activates the Coupler Trim Function for the currently selected coupler. This provides a fine calibration adjustment by shifting the ***entire coupler calibration curve*** up or down by up to +- 1%. You may want to use this function if you inadvertently upset the side panel calibration pot after calibration. You can readjust that Coupler Trim pot as closely as possible and then do the final touch up with the TRIM function using the high precision front panel pot. This trim function can be used for any purpose however, and can be used with RF Ammeter and Generic Meter applications as well.

LED Indicator on the Coupler Shortcut Button COUP:

When the yellow LED is lit, this indicates that one of the Virtual Couplers (Coupler 5 – 8) is selected.

When you activate the coupler TRIM function (described in detail below), the yellow LED on this switch will flash as a reminder that you are in the TRIM mode.

Notes – RF Ammeter and Generic Meter Couplers: When a coupler is selected that has been configured for an RF Ammeter or Generic Meter application, all of the measurements that are specific to a power measurement coupler, ***but that are not applicable*** to an RF Ammeter or Generic Meter application, such as SWR, Reflected Power, and Delivered Power, will be blocked (skipped over) when you scroll through the different displays modes using the menu buttons. Furthermore, if a display device is currently set to a ***non-applicable parameter*** and an RF Ammeter or Generic meter coupler is subsequently selected, the software will automatically set the display mode for that device to "OFF". To re-enable that device, simply select a "legal" display mode from the menu. As discussed above, you will be offered only selections that are valid for the currently selected coupler type.

For RF Ammeter and Generic Meter applications, the applicable display modes are:

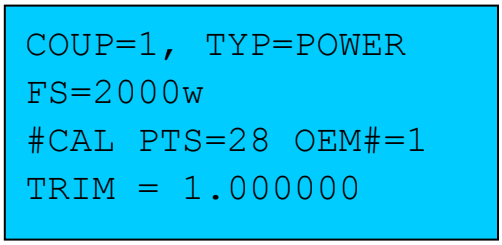
- TUNE (For RF Ammeter or Generic meter applications, this corresponds to the instantaneous value of the parameter being measured)
- AVG
- PEAK
- Min/Max captures of the above three measurements.

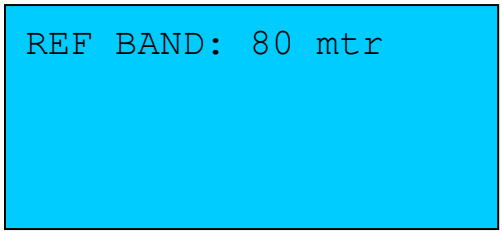
3.8.1 Displaying Coupler Settings

Function: Displays key calibration settings of the ***current coupler***.

To enter Display: Select the coupler menu. Then select the desired coupler number with M1. Then press the Display Shortcut button **DISP** (short press). This will bring up the first page of settings. Keep pressing the Settings button repeatedly (short press) to view the remainder of the settings, and to finally to exit the display mode (returning the meter to normal operation) after the last page is displayed.

Sample Display of Coupler Settings

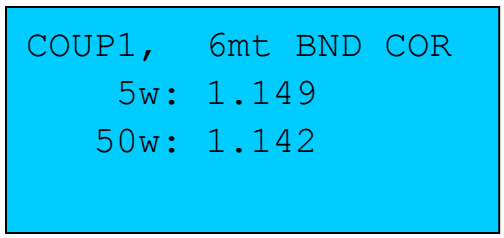




The screen below shows the actual calibration points with respect to the Programmable Amp/ADC chain. There could be multiple screens of this calibration data depending upon the number of calibration points you set up during the coupler's calibration.

-
-
-

The screen below shows the band correction factors for this coupler as a function of both band and power. The data for the 6 meter band at the 5 watts and 50 watt power levels is shown in the sample screen below). Again, there could be multiple screens depending upon the number of calibration points you set up for each band, and the number of bands that were calibrated.



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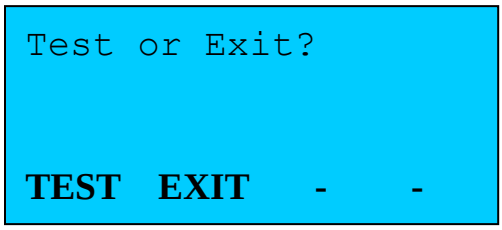
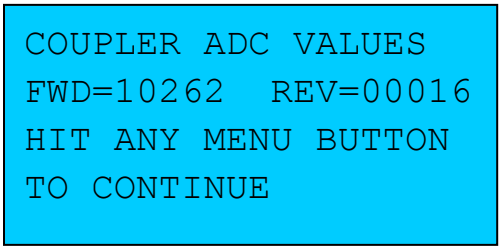
Before exiting the display screens, you are given the option to TEST the coupler. The Coupler Test simply reports the current ADC input levels being read at the coupler input by the software. An input must be applied to the coupler ports to obtain a valid reading. This is a quick way to make sure that a coupler is connected to the correct jacks, and is applying a signal to the meter head.



Sample Test Screen Reporting FWD and REFL ADC Values after pressing "TEST" option.



3.8.2 Setting Forward Trim on a Calibrated Coupler

Function: The Trim function provides an additional fine adjustment of a coupler's forward power calibration using the 10-turn high precision pot on the front panel of the meter. The pot is used only to "dial in" a correction factored, which is saved in the calibration table.

This trim function is done at a voltage point in the software, and therefore shifts the entire calibration curve up or down. It may be used for any coupler input: power couplers, RF Ammeters, or user-provided analog sensors.

You will not normally need to use the Trim function. However, if you want to fine tune the entire calibration curve for any reason, you can use this feature. This includes final trim following an adjustment of side panel coupler trim pots.

Once the Trim operation is completed, the trim factor is saved in EEProm for the current coupler, and is retrieved with the coupler calibration table and placed into effect when that coupler table is later loaded.

This Trim function is designed to provide approximately a +- 1% maximum adjustment of the current calibration. If you modify MB-1's TUNE reading sufficiently using the Trim feature, this indicates the side panel adjustment pot is too far out of range. In this case, reset the Trim to 1.0 (via the DEFAULT choice). Then readjust the side pot for a more accurate reading before proceeding with the Trim operation.

Using the Trim Feature:

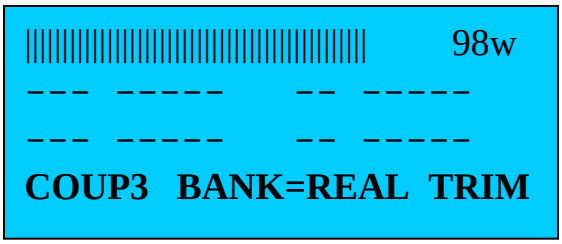
The following describes how to use the Trim feature with a power coupler. For RF ammeter couplers, or generic meter applications, the operation is essentially the same.

1. Insert a reference meter in series with the coupler that is being trimmed. Terminate the reference meter in a 50 ohm resistive load.

2. To achieve maximum display resolution, configure MB-1 to display Instantaneous (TUNE) power on one of the seven segment displays (which have a precision of up to two digits after the decimal point).

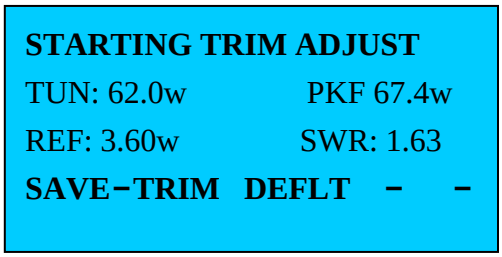
3. Preset the front panel pot by setting it about half way through its travel (approximately 5 turns from either stop).

4. Press the Coupler shortcut button **COUP** and select the coupler you want to trim with M1. The main coupler menu is repeated below.



5. Enter the trim mode by pressing M3 (TRIM). The menu line will now change to the screen shown below, and the yellow LED on the **COUP** button will start to flash (to remind you that you are in the TRIM mode).

Coupler Trim Menu



6. While in the trim mode, apply a moderate signal level (e.g., 50 watts). Adjust the front panel precision pot until the TUNE power measurement on MB-1 agrees with the independent reference device that has been placed in tandem with MB-1. Turn the front panel pot clockwise to increase the MB-1 reading, and counter clockwise to decrease the MB-1 reading.

7. When the MB-1 reading and reference meter reading are in agreement, press M1 (**SAV-TRIM**). This will terminate the Trim operation and will save a correction factor for the associated coupler in EEProm.

8. If you press M2 (**DEFLT**) instead, the trim operation will end and the no correction will be applied. (The trim factor is reset to its default value of 1.0).

9. Whether the correction factor is saved or the operation is aborted by selecting **DEFLT**, the menu will revert back to the Coupler menu, and the meter will return to normal operation.

Error Messages:
The TRIM function is not valid for Virtual Couplers. An attempt to use the trim function with a Virtual Coupler will results in an "Invalid Operation" error message.

While in the TRIM mode, all buttons and operations are locked out until you terminate the TRIM operation by either returning the trim value to its default value of 1 (by pressing M2), or by saving the current trim value (by pressing M1). An attempt to select any other button or to apply a long push to buttons M1 or M2 will result in an "Illegal Button" or "Invalid Operation" error message respectively.

3.9 Digital (Seven Segment) Display Operation

Function: Specifies the measurement type or configuration value that will be displayed on each of the four internal seven segment modules, and on each of the two external 7-segment displays (if equipped).

In addition to displaying measurement values, any of the 7-segment display modules can be set up to display meter configuration information as well, such as:

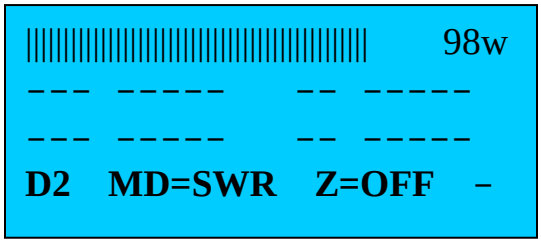
- The number of the currently selected coupler
- The current band
- The current full scale range of the Panel Meter
- The current AutoMax (or manual) full scale value of the Bar Graph.

You can mix and match measurement data and configuration data any way you see fit when setting up the 7-Segment displays.

During setup of the seven segment displays, you can also individually control whether leading zeros will be suppressed on a per module basis. For example, you may want to suppress leading zeros for SWR measurements and some of the configuration data (e.g. Coupler "2" vs. Coupler "0002" when displaying the active coupler number). However, you can configure these any way you see fit.

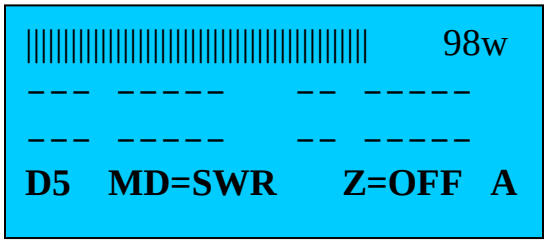
To Activate Menu: Press the 7-Segment Display shortcut Button **7-Seg**. The 7-Segment display menu will appear on line 4 as shown below.

7-Segment Display Menu for Internal 7-Segment Modules 1-4



Example: D2 SWR Z=OFF –
In this example, 7-segment display module D2 is being configured. Module D2 is set to display SWR. Leading zeros are turned OFF (leading zeros are being suppressed).

7-Segment Display Menu for External 7-Segment Modules 5-6



Example: D5 SWR Z=OFF A

This example is identical to the above example except that an extra menu field (field 4) is required when the ***module being configured is an external seven segment module*** (module 5 or 6). Modules 5 and 6 are the Hi-Visibility external modules that are connected to the 10 pin IDC jacks on rear of the meter. In this example, module 5 is configured as a "**TYPE A**" external module. See the description for field 4 below for additional information.

Modules 5 (and 6 if you have configured MB-2 to drive two hi-visibility seven segment displays) are connected to rear panel connectors "**Ext 7-Seg 1"** and "**Ext 7-Seg2 or Ext Bar Graph"** connectors respectively. Depending on the size of the external 7-segment module you are using (they are available in 1.5 inch to 7 inch sizes) the device requires one of four software protocols. To distinguish the different protocols required by the devices, we use the terminology **TYPE A, TYPE B, TYPE C,** or **TYPE D** devices. Each push of M4 will select the next character in the sequence A, B, C, D.

The 1.5 inch 7-segment external display is a **TYPE A** device All of the remaining SURE 7-segment modules, with the exception of the 7 inch modules, are **TYPE B** devices. The largest (7 inch) module will run as a **TYPE C** or **TYPE D** devices. If you set the 7 inch modules to **TYPE C** (which selects a software driver programmed to the manufacturer's specs), you will notice a slight amount of flicker. If you find the flicker objectionable, set the type to **TYPE D**. This causes the software to use a modified driver that avoids, the flicker, but does so at the expense of some performance. In most cases, the performance impact will not be significant, but you should be aware of this tradeoff.

See section 13.1 for a detailed description on this topic.

Field 1 – Displays current Seven Segment module being configured.

Choices:

D1 – D4 (internal display modules)

D5 (if external hi-visibility devices have been configured for one hi-visibility 7 segment device, and one hi visibility bar graph).

D5 – D6 (if external hi-visibility devices ***have been configured for two hi-visibility 7 segment devices, and no hi visibility Bar Graph***).

Field 2 – Displays the measurement value or configuration parameter to display on the module selected in Field 1.

Choices:

OFF – The selected 7-segment module is turned off

TUNE – Instantaneous FWD power

AVG - Average FWD power

PK-FWD or **PK-DEL** – Peak FWD power or Peak delivered power (FWD peak – REFL peak). The Peak Forward or Peak Delivered selection is made globally for all peak power measurements using the LCD setup menu (see section 3.12).

REFL – Reflected power

DELV – Delivered (FWD – REFL) power

SWR – Computed SWR value

PANMTR – Panel meter full scale value of current range – particularly useful when the Panel Meter is in the AutoRange mode.

BG-FS – Current Bar Graph Full scale value as established by the Bar Graph **AutoMax** function, or as selected via a manual range by the user.

BAND – Currently selected band

COUPLR - Currently selected coupler number

MIN-MAX Parameters – the parameter being processed by the Min/Max function (which must be selected via the Min/Max menu). The following shows the mapping for the MIN function. The mapping for the MAX function is the same except that the word **MIN** is replaced by **MAX**.

MINSWR – Minimum SWR
MINTUN – Minimum Instantaneous (TUNE) Power

MINTUF – Minimum (TUNE) Power with filtering
(see notes in section 3.13)

MINAVG – Minimum Average Power
MINPK – Minimum Peak Power
MINREF – Minimum Reflected Power
MINDEL – Minimum Delivered Power
MINOFF – Min/Max function is off

Field 3 – Indicates whether leading zeros will be displayed or suppressed on the selected 7-segment module.

Choices:

Z=OFF – Leading Zeros are OFF (suppressed)

Z=ON – Leading Zeros are on

Notes: For information on configuring the number of external 7-segemnt displays, see sections 4.1.3 and 4.1.4.

Field 4 – **Software Driver Type -** This field applies only to 7-Segment module 5 or 6 (the External Hi Visibility modules).

Modules 5 (and 6 if you have configured MB-2 to drive two hi-visibility seven segment displays) are connected to rear panel connectors "**Ext 7-Seg 1"** and "**Ext 7-Seg2 or Ext Bar Graph"** respectively. Depending on the size of the external 7-segment module you are using (they are available in 1.5 inch to 7 inch heights) the device requires one of four software protocols (**TYPE A, TYPE B, TYPE C,** or **TYPE D)**. Each push of M4 will select the next software driver from the set A, B, C, D.

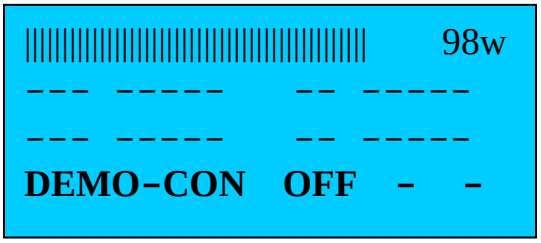
Note, also that the power requirements for TYPE A, TYPE B, TYPE C and TYPE D devices are different Use caution when setting the jumpers on the EXT7SEG1 header and EXT7SEG2 header for 5 volts or 12 volts on the Controller PCB. This topic is covered in detail in section 13.1.

3.10 Demo Mode (Simulator)

Function: The Demo mode makes use of the built-in simulator to generate pseudo random measurement values or other pre-defined measurement sequences that can be used to drive the meter software without actually having to connect the meter to a transmitter or load. This is useful for familiarizing yourself with the various features of the meter. It also allows you to set your preferences for settings such as the peak hold time and panel meter decay time without actually transmitting live. Last, the Demo mode is useful for validating the calibration and operation of any external panel meters that you may have set up.

To Activate Menu: Press the Demo mode shortcut Button **Demo**. The Demo mode menu will appear on line 4 as shown below.

Demo Mode Menu



Example: DEMO-CON – Simulator is set to continuous mode

Field 1 – Displays current Demo mode.

Choices:

OFF – Demo mode is off.

CON – Continuous mode - Random power values upper bounded by the full scale range of the current coupler are generated continuously.

VAR – Variable mode - Random power values within the full scale range of the coupler are generated with a periodic pause (0 power during the pause). The cycle repeats indefinitely.

ST1 – random values within the full scale range of the coupler are generated and held, with approximately a 1 second hold between steps.

ST2 – Same as ST1 but the hold delay between steps is approximately 5 seconds.

SWP – samples are generated from 0 to the max full scale value of the currently selected coupler in an approximate saw tooth timescale. This is useful for linear sweeping through a panel meter scale.

FS - generates and holds all samples at a value corresponding to the full scale output of the currently selected coupler.

Field 2 – Press M2 to **OFF** to quickly turn off the Demo mode with a single press (without having to cycle through the entire set of modes to reach "OFF" using M1).

Default Full Scale and SWR Values:

The simulator used by the Demo mode feature comes with default values for the four virtual couplers (Couplers 5 – 8). The default values are given in **Table 5**.

Real Couplers:
The Demo mode can also be used when a ***real coupler*** (Couplers 1 – 4) is selected. When used with a real coupler, ***the full scale simulated value will be equal to the full scale value that was specified when you set up that coupler during calibration.*** When a real coupler is selected for use with the Demo mode, the inboard simulator generates a simulated SWR of 3.0.

Notes:

Variable SWR: Coupler 7 (a virtual coupler) provides a variability of 1 SWR unit while generating the simulated sequence. Therefore, if you program the nominal SWR value to 2.5 (which is also the default value for this coupler), the simulated SWR values for this coupler will range, randomly, from 2.5 to 3.5 as the sequence of simulated measurements is generated. This variability in SWR is useful for familiarizing yourself with the SWR alarm features (e.g., you can set your SWR trip point to 3.0 and have the meter generate the selected alarm indications when a simulated SWR exceeds your specified threshold).

Simulated Band Compensation Factors: This discussion should help you understand how band compensation is performed by MB-1. Even though this discussion applies to the Virtual Couplers, the overall concept is applicable to real couplers as well.

The three virtual power couplers (couplers 5 – 7) have simulated band correction factors associated with them ***for the 10 meter and 6 meter bands***. You can see how band correction works using the Demo mode. Select one of the virtual power couplers (5 – 7), turn the Demo mode on, and then select either the 10 meter or 6 meter band with the Band menu (section 3.3). Then select the **SHOW** option via the Band menu on line 4. With the Demo mode running, you will see the band correction factors being applied in real time on line 4 of the LCD as a function of the simulated power values. Interpolation is used to calculate the band correction values for ***every measurement*** based on the number of available band correction data points.

If you reprogram the Demo mode with your own full scale values, band correction points that will be used are based on the full scale power value you selected when programming the Demo mode. The actual correction factors are the same ones used for the default settings shown in **Table 5**.

For the virtual couplers, the number of simulated band correction factors for the 10 meter and 6 meter bands as well as the actual correction factors will always be the same - you cannot change these simulated band correction factors). All band compensation points within the range of your full scale value, up to and including 1000 watts, will be automatically configured by the software each time you reprogram the simulated full scale values. Up to five band compensation points are provided for each of the two bands programmed into the simulator. **Table 7** below specifies the values.

Note – if you use the Demo mode with a real coupler (couplers 1 – 4), the band compensation factors, if any, that you programmed during the actual Coupler calibration, will be used by the simulator.

Table 7 - Virtual Couplers –
Simulated Band Compensation Factors as a function of Full Scale Power

Full Scale Power (in watts) of Virtual Power Coupler	Number of Simulated Band Compensation Points for 10 Meter and 6 Meter Band	Power Level Points for Frequency Compensation	10 Meter Compensation Factors	6 Meter Compensation Factors
5 <= FS < 50	1	5 watts	1.032	1.074
50 <= FS < 150	2	50 watts	1.037	1.0840
150 <= FS < 500	3	150 watts	1.042	1.094
500 <=FS < 1000	4	500 watts	1.047	1.104
FS >= 1000 watts	5	1000 watts	1.052	1.114

For example, if you program the full scale power of a virtual coupler to 10 watts, you will have one band compensation point (at 5 watts) on both the 10 meter and 6 meter bands. If you program the full scale power of a virtual coupler to 1000 watts, you will have five band compensation points on both the 10 meter and 6 meter bands as per the table above.

Definitions: Simulator and Virtual Couplers
To prevent confusion, some definitions are in order at this point. Both the terms "simulator" and "virtual coupler" are used in this manual. The meter accommodates up to four real couplers (1 – 4) and four virtual couplers (5 – 8). The ***virtual couplers*** can be programmed for use with the Demo mode (simulator) with their own full scale value and SWR value, and can be used to check meter functions such as the calibration of an external Panel Meter.

The ***Simulator***, on the other hand, is the software module that generates simulated measurements used by the Demo mode feature. While the virtual couplers can only be used in conjunction with the Demo mode feature, ***the Demo mode can also be used on any of the four real coupler ports (1-4).*** When used with the real couplers, the simulator will use the full scale value set up during calibration of the real coupler when generating its simulated values. To summarize, keep in mind that the simulator and virtual couplers are two different things.

LED Indicators on the Simulator Shortcut Button:

The yellow LED on the Demo mode shortcut button is lit when the Demo mode is on (to remind you that the simulator is currently running).

3.10.1 Displaying Demo Mode Full Scale Settings

Function: Displays the currently programmed Full Scale power and SWR values for each of the virtual power couplers (5-7), and displays the Full Scale current of the virtual RF ammeter (coupler 8).

To enter Display: With the Demo mode menu displayed on line 4, press the Display Shortcut button **DISP**. This will display the Demo mode settings for the four virtual couplers. Press the **DISP** button again to exit the display mode and return the meter to normal operation.

Demo Mode Settings for Virtual Couplers

```
COUP5:   20w   SWR=3.0
COUP6:  200w   SWR=2.0
COUP7: 2000w   SWR=2.5
AMMETER8:    20a
```

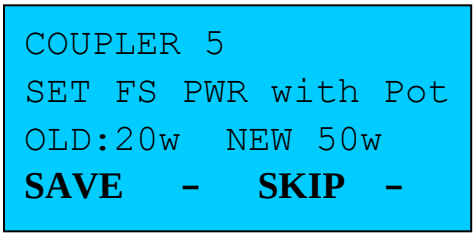
As shown above, when using the Display function with the Demo menu, the band compensation factors are not displayed for the Virtual couplers. To view the Band Compensation data, select the virtual coupler using the Coupler menu. Then press the Display button (see section 3.8). This will show you all of the coupler calibration data for the selected coupler, including the band calibration factors.

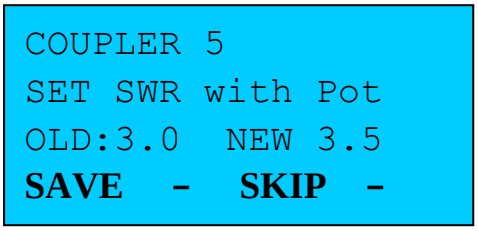
3.10.2 Programming the Virtual Couplers

Function: Allows you to program full scale power and SWR values for each of the three virtual power couplers (couplers 5 - 7) and the full scale current of the virtual RF ammeter (coupler 8) if the default values do not meet your needs.

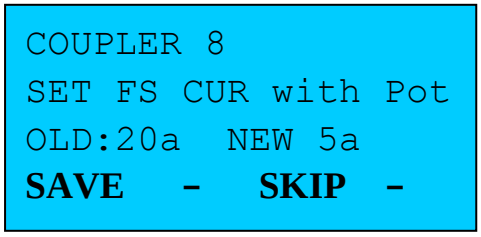
To enter Setup: With the Demo mode menu displayed on line 4, press **Set-Up**. This will bring up the Demo mode Setup screen. For those existing entries that you wish to keep, press **SKIP** (M3). This will advance you to the next entry. To change a setting for any of the virtual couplers, dial the **NEW** desired value with the front panel pot. Then press the SAVE Button M1.

Programming the Virtual Couplers





…



Notes:

Simulation Ranges for Virtual RF Power Couplers (Couplers 5 – 7):
Each full scale power range (couplers 5 – 7) may be set from 1 watt to 30,000 watts.
Each SWR range (couplers 5 – 7) may be set from 1.0 to 9.0.

Simulation Range for Virtual RF Ammeter Coupler (Coupler 8):
The last virtual coupler (coupler 8) is a virtual RF ammeter coupler. Its full scale value may be programmed from 1 – 30,000 amps. This large upper range, although not needed for RF Ammeter applications (where 3 – 5 amps are reasonable values), is allowed because virtual coupler 8 can also be used for simulation with Generic Meter applications as well. Because the possible range of Generic Meter applications cannot be anticipated, the maximum value that can be processed by the Demo algorithms (30,000) is allowed to provide flexibility in exercising any Generic Meter Application.

Affect of Band Correction Factors:
For the power couplers, the full scale values you specify when programming the virtual couplers apply to the reference band only. If the coupler you are running the simulator with has band calibration factors associated with it (applies to real couplers as well as virtual couplers), when you select bands that have been calibrated, the simulated power values (and hence the full scale power value) will be adjusted up or down accordingly based on the correction factors, just as it would be for real operation.

Limitations when using the Simulator with Generic Meter Functions:
If a Generic Meter function is calibrated at more than one point, the software will limit the actual measurement values that can be displayed on MB-1 to the lowest and highest calibration points. For example, assume that you calibrated a Generic Application with a full scale value of 100 units. Assume further that the smallest calibration point that the application was calibrated at is 20 units, and the largest calibration point that the application was calibrated at is 70 units. If you use the simulator to exercise the Generic Application, ***simulated values will be generated with values between 0 and the full scale value***. In other words, the simulator will produce measurement values both lower (less than 20) and higher (greater than 70) than when MB-1 is running with the real application.

Conditions under which the Simulator is turned off:
Whenever the Coupler calibration setup routine or Panel Meter Calibration routine is entered, the simulator is turned off. If you wish to re-enable the simulator after exiting either of the above two setup routines, simply use the **Demo** menu.

3.11 EEPROM Backup/Restore/Update from PC

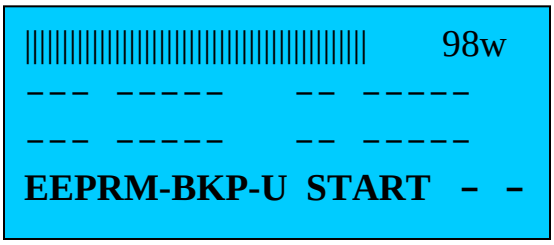
Function:

BACKUP/RESTORE: This menu allows you to interface with the provided PC-based utilities to back up and restore the EEProm image to/from a PC file. You will find this feature particularly useful, for example, if you accidentally delete a coupler calibration table or Panel Meter calibration table that you have spent some time setting up. This utility restores the entire User Section of the EEPROM. (The EEProm partitioning is described in detail below).

This backup/restore software on the MB-1 works in conjunction with a **TeraTerm** macro that runs on the PC. Complete instructions for running the Backup/Restore/Update utilities from a PC are given in section 11.

To Activate Menu: Press the UP or DOWN menu button until the EEPROM Backup/Restore menu is displayed as shown below

EEPROM Backup menu



Example: "EEPRM-BKP-U START - -

The EEPROM menu is primed to start the Backup operation of **U**ser data section of EEProm. The data will be loaded into a PC file for subsequent restoral.

Field 1 – Selects the Backup or Restore operation.

Choices:

Backup Options:

BKP-U – Backs up the ***user section*** of EEPROM (which contains all of the user settings, coupler tables for couplers 1-4, and all of the panel meter calibration tables. The data is copied from MB-1 EEProm to a PC file named ***mb1_user.data***.

RESTORE/UPDATE Options:

RST-U – Restores the ***user section*** of EEPROM, which contains all of the user settings, coupler calibration tables for couplers 1-4, and panel meter calibration tables. The restore operation is done from a previous PC backup file named ***mb1_user.data***. For this operation, data is copied from the PC file into the ***user section*** of EEProm.

RST-O – Updates the ***OEM section*** of EEPROM, which contains the preloaded calibration tables for popular (OEM) couplers. The restore operation is done from an update file named ***mb1_oem.data*** that you can download from the MeterBuilder website. For this operation, data is copied from the PC file into the ***OEM Coupler Preset Table*** section of EEProm.

Field 2 –M2 (the **START button)** is pressed to initiate the backup, restore, or update operation selected in field 1.

Notes: - EEPROM is divided into two sections: ***User Data*** and ***preloaded OEM coupler tables***. Any configuration changes you make, including calibration of any of the four couplers, and five panel meters (max), are stored in the ***User Data section of EEProm data only***. ***This is the data you want to back up so that ALL of your settings, including coupler and panel meter calibration tables, can be easily restored.*** The table below shows how the EEPROM data is partitioned.

Table 8 – EEPROM Data Partitioning

EEPROM Address	Data
Lower 7696 bytes of EEPROM	This data consists of user settings (***User Data)*** including Coupler and Panel Meter Calibration Tables set up by the User. Use the **BKP-U** and **RST_U** options from this menu to backup or restore this data to/from a PC file ***mb1_user.data***.
Upper 8688 bytes of EEPROM (16 KB EEPROM) Upper 25072 bytes of EEPROM (32 KB EEPROM that is included with Expansion Kit)	***OEM Coupler Preset Tables*** for MB-HF1 coupler with capability to add calibration tables for other popular couplers. You do not need to backup and restore this data. However if MeterBuilder issues updates to the OEM coupler calibration tables, you can download the latest set of OEM Coupler tables from the MeterBuilder website, and then use the **RST-O** option to update the OEM tables in your MB-1. The file used for this operation is named ***mb1_oem.data.***

Updating the Preloaded OEM Coupler Calibration Tables:

The ***OEM coupler section*** of EEPROM is preloaded from the factory with the factory calibration tables for the MB-HF1 coupler and other popular couplers from other manufacturers. As MeterBuilder issues updates to this data (for example, to add support for additional couplers), you can use the ***update option*** of this menu (RST-O) with an updated ***mb1_oem.data data file obtained from the MeterBuilder website*** to update your MB-1.

Of course, you do not have to use OEM codes at all when setting up your own couplers. You always have the option to do a full custom calibration, as described in section 5, on any Bruene type coupler, including the ones supported in the OEM tables. However, the factory loaded OEM preset calibration tables simplify the operation for the supported couplers since you only have to specify only the correct OEM code during coupler setup.

Updating the OEM data section of EEProm requires no firmware updates, nor does it modify your existing meter settings, coupler calibration settings (coupler tables for couplers 1 4), or panel meter calibration tables.

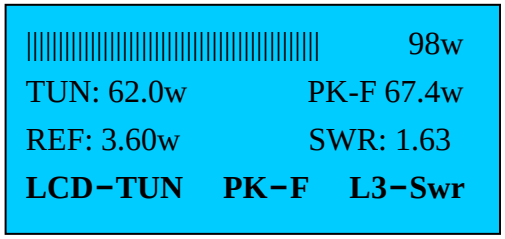
Complete instructions for running these Backup/Restore/Update utilities from a PC are given in section 11.

3.12 LCD Configuration

Function: Controls the information that is displayed on the 4x20 LCD.

To Activate Menu: Press the LCD Configurations shortcut Button **LCD**. The LCD menu will be displayed on line 4 as shown below. Note – the layout of the LCD display was discussed in detail in section 2.6.

LCD Menu



Example: LCD-TUN PK-F L3-Swr

The forward power mode (leftmost item on line 2) is displaying instantaneous power (**TUN**E).

The peak power mode is peak-forward power (as indicated by the **PK-F** header on line 2).

Line 3 of the LCD is set to show Reflected Power and SWR (vs. the Min/Max values).

Field 1 – Forward Power Options (controls leftmost item on line 2 f the LCD).

Choices:

TUN – Instantaneous Forward power
AVG – Average Forward power
DEL – Delivered (net) instantaneous power (FWD power – REFL power)
OFF – The entire LCD display is turned off except for the menu line (line 4).

Example TUN: 62.0w – The Instantaneous Forward power (TUN) is selected, and is displayed as the leftmost item on line 2 (62.0 watts).

Note: DEL (delivered power) is not a valid selection for RF ammeter couplers or generic couplers, and that menu choice will be automatically bypassed for those coupler types.

Field 2 – Peak Power Mode (controls ***peak mode*** of the rightmost item on LCD line 2).

Choices:

PK-F – All displayed peak power values (global) are Peak Forward power measurements.

PK-D – All displayed peak power values (global) are Peak Delivered power measurements (Peak FWD power – Peak REFL power).

Example: PK-F 67.4w –Peak Forward power is selected, and is displayed as the rightmost item on line 2 (67.4 watts).

Field 3 – LCD Line 3 information – Determines the information displayed on line 3 of the LCD.

Choices:

L3-Off – Line 3 is turned off completely.
L3-Swr – Reflected power (left) and SWR (right) are displayed on line 3.
L3-Max – The Min and Max values of the parameter being processed by the Min/Max function are displayed on line 3. The Min value is the left item on line 3. The Max value is the right item on line 3. The heading is applied to the left of the Min value only, which indicates the parameter type that is being processed by the Min/Max function.

MIN-MAX Parameters – The following information applies when line 3 of the LCD is set to display Min/Max values (vs. Reflected Power and SWR). The parameter being processed by the Min/Max function is identified in the leftmost item on line 3. The numerical value to the right of that heading is the minimum value measured since the last Min/Max reset.

The rightmost numerical value on line 3 is the maximum value measured since the last Min/Max reset. Note – to conserve space, the heading that identifies the Min/Max value that is being processed ***is prepended to the minimum value only***. The Min/Max function can process 7 different measurement types as shown below. The following are the tags that are displayed on line 3 for each of these modes:

TUNMIN – Instantaneous (TUNE) Power
TUFMIN – (TUNE) Power with filtering (see notes in section 3.13)
AVGMIN – Average Power
PK-MIN – Peak Power
REFMIN – Reflected Power
DELMIN – Delivered Power
SWRMIN - SWR
MINOFF – Min/Max function is off

Example (when Reflected power and SWR are being displayed on line 3):
REF: 3.60w SWR: 1.63
Reflected power and SWR are being displayed on line 3, and the values are 3.60 watts and 1.63 respectively.

Example (when Min/Max are being displayed on line 3):
SWRMIN 1.12 1.28

Min/Max values are being displayed on line 3. The current parameter being processed by the Min/Max function is SWR, and the minimum and maximum SWR values measured since the last Min/Max reset operation are 1.12 and 1.28 respectively.

Notes: The peak power mode set from field 2 of this menu (Peak Forward or Peak Delivered) is a global setting for *all meter functions that make use of peak power*.

3.12.1 LCD Configuration Error Messages

INVALID OPERATION – For RF ammeter and generic meter couplers, only the Peak Forward power mode is applicable (FWD – REFL makes no sense for these coupler types). An attempt to switch to Peak Delivered mode will result in this error message.

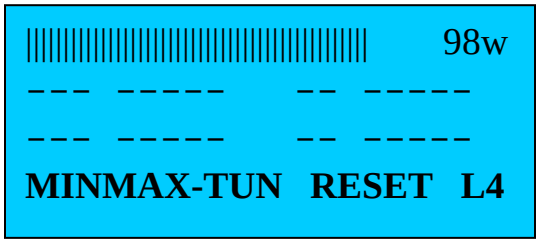
3.13 Min/Max Functions

Function: Selects the measurement parameter to be processed by the Min/Max function. The Min/Max function monitors the selected parameter, and displays the minimum and maximum values of that parameter on a user-specified display device. Updating of the minimum and maximum values will continue indefinitely, or until reset by the user, which starts a new acquisition interval.

Choosing a measurement to be processed by the Min-Max feature will not automatically display the Min and Max values. You must configure one of the display devices (LCD line 3, Panel Meter, Bar Graph, 7-Segment Displays) to display the Min and/or Max values. Note however that the min/max values are being processed and updated even when not being displayed.

To Activate Menu: Press the Min/Max shortcut Button **MinMax**. The Min/Max menu will be displayed on line 4 as shown below.

Min/Max Menu



Field 1 – Displays the measurement parameter that will be processed by the Min/Max function.

Example: MIN/MAX-TUN – Instantaneous forward power (TUNE) is being processed by the Min/Max function.

Choices:

OFF – Min/Max function is off.

TUN – Instantaneous Forward Power

TUF – Forward Power – with Filtering (see Notes section)

AVG – Average Power

PK - Peak Power (Forward Peak or Delivered Peak power as globally selected in the LCD menu).

REFL – Reflected Power

DELV – Delivered (net) power (FWD – REFL)

SWR – SWR

Field 2 (RESET) – Resets the minimum and maximum values and starts acquiring a new set of Min/Max values.

Field 3 (L4) – Forces the Min/Max display to appear on line 4 of the LCD (which is normally reserved for menus). This allows you to display ***both*** the REFL/SWR information (on line 3) ***and*** the Min/Max information (on line 4) simultaneously on the LCD. (Normal setup of the LCD allows either REFL/SWR or MIN/Max values to be displayed on line 3 of the LCD).

If the Min/Max information is displayed on line 4, as soon as you request a menu, the Min/Max display information will be removed from line 4 and replaced by the menu (which is the default meter operation for line 4). ***Therefore, displaying Min/Max values on line 4 should be viewed as a temporary configuration only*** for which you wish to view both Reflected Power/SWR (on line 3) and Min/Max data (on line 4) at the same time. If this special use of line 4 for Min/Max is requested when the Min/Max data ***is already being displayed on line 3 of the LCD***, Line 3 will be turned off by the software (thereby preventing redundant information on lines 3 and 4).

Min/Max Shortcut Button Functions:

Long Push of **Reset** **–** Resets both the current minimum and maximum values, and starts acquiring a new set of min and max values.

Notes:

Tune Modes – Instantaneous vs. Filtered:
There are two "TUNE" (instantaneous) modes: **TUN**, and **TUF**. The first mode (**TUN**) is the best mode to select if you are looking for the fastest response when attempting to detect short duration overshoot and dropout conditions or other short term transient conditions. To make this mode as responsive as possible the "instantaneous mode" samples are used when you select **TUNE**. These samples are the raw data from the A-to-D chain without any digital filtering. As such, a certain amount of the difference you observe between the Min and Max values will be due to noise in the measurement process (including quantizing noise).

If you want to monitor slower variations in power (such as power creep of your output stage as the output transistors in final stage of your transceiver heat up during key-down), the **TUF** (Tune with Filtering) mode is the better mode to use. Its response is slower than the **TUN** mode, but since filtering is applied in this mode, any noise from the measurement process is reduced to nearly 0. This is the mode that should also be used for Generic Meter applications when the "Generic" parameter being measured is known to vary slowly with time.

Selection of either TUN or TUF under the Min/Max menu ***affects only the display devices that are displaying Min or Max values***. Pick whichever mode suits the task at hand.

Note – when using the Min/Max feature to display Delivered power (**DELV**) or Reflected power (**REFL**), the filtered version of these signals are used.

Limitations of Min-Max function when used with SWR:
To prevent erroneous indications when the Min-Max function is monitoring the SWR, a change in the SWR value must persist for approximately 500 milliseconds to be registered by the Min-Max function.

For SWR measurements, the measurement tolerance of the Min/Max function is approximately +-0.2 SWR units when the nominal SWR value is below 3.0. A larger variation will be seen when the nominal value of the SWR is larger than 3.0. The largest variation in the SWR Min/Max function will be seen with time varying signal, such as SSB, since MB-1 continues to compute the SWR even during "silent intervals" as long as the power exceeds the **Minimum Power for Valid SWR** setting in the ALARM menu (section 3.1.2). This limitation is a result of tradeoff between response time and accuracy.

To achieve the best performance for the SWR Min/Max function, set the **Minimum Power for Valid SWR** setting in the ALARM menu to the largest possible value commensurate with your operating power.

The above limitations do not apply to the other measurement types.

Whenever you change couplers, Min/Max mode, etc, you should reset the Min/Max values with a long push of the **Reset** button.

3.14 Panel Meter Operation

Function: The Panel Meter menu is used to select the active panel meter (if you have more than one panel meter configured). It is also used to specify the type of measurement that will be displayed on the active Panel Meter, and to select the manual range.

The capabilities and limitations of the Panel Meters are primarily a function of the meter movement type that you are using for the Panel Meter as summarized in the table below. (The meter supplied with MB-1 is a crossneedle meter).

Table 9 - Panel Meters – Scale Configurations

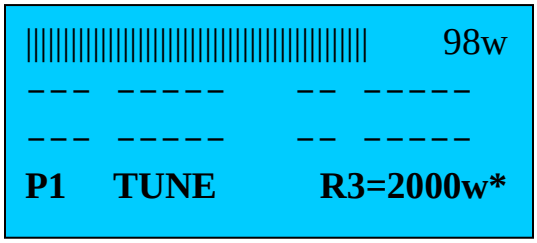
Scale Type	Max Number of Power scales	Max Number of SWR scales	Max full scale Power	Measurements that can be displayed on this type of Panel Meter
Linear - single needle	12	3	30,000 watts	OFF, TUNE, AVG, PK-FWD or PK-DEL, REFL, DEL, SWR,MIN-parm MAX-parm
Non-linear – single needle	3	1	30,000 watts	OFF, TUNE, AVG, PK-FWD or PK-DEL, REFL, DEL, SWR, MIN-parm, MAX-parm
Crossneedle – linear or non-linear scale	3	NA	30,000 watts	OFF, TUNE, AVG, PK-FWD or PK-DEL, DEL, MIN-parm, MAX-parm (SWR is not an explicit choice for a Crossneedle meter since it is displayed via the intersection of the FWD and REFL needles when the mode is set to TUNE)

Other Panel Meter Functions:

AutoRange – If you configure more than one power range or SWR range when setting up a Panel Meter, you can activate the Panel Meter's AutoRange function, which will automatically select ***the most sensitive scale that does not result in an overrange***. You can toggle the AutoRange function on and off with a long push of the **Autrng** button.

Soft Overrange – During Panel Meter setup, you can define a soft overrange limit that allows some needle excursion beyond the meter movement's full scale deflection when an overrange condition is present. This gives you a visual indication of an overrange condition without risking damage to the meter movement. Five to ten percent beyond full scale provides a detectable overrange indication without risking damage to the meter. Panel Meter calibration is described fully in section 5.

To Activate Menu: Press the Panel Meter shortcut button **PanMtr**. The Panel Meter menu will be displayed on line 4 as shown below.



Example: P1 TUNE R3 =2000w*
In this example, Panel Meter 1 is selected. The Panel Meter is displaying instantaneous forward power (TUNE). The current scale (range 3) is set to 2000 watts. The asterisk indicates that the Panel Meter's range is being selected automatically by the AutoRange function.

Field 1 – Displays the number of the current Panel Meter.

Choices:

P1 – P6 – Panel meters 1 – 6. Crossneedle meters require ***two panel meter ports***. Because of this, crossneedle meters must be configured on either panel meter port **1, 3, or 5.**

Field 2 – Displays the measurement type to display on the Panel Meter.

Choices: (see Table 9 - Panel Meters – Scale Configurations above for which measurements can be displayed based on meter movement type)

OFF – Turn off Panel Meter

TUNE – Instantaneous FWD power

AVG - Average FWD power

PK-FWD or **PK-DEL** – Peak FWD power or Peak delivered power (FWD – REFL). The Peak Forward or Peak Delivered selection is made globally for all peak power measurements using the LCD menu.

REFL – Reflected power for single needle meters. For Crossneedle meters, reflected power is displayed simultaneously with forward power when the **TUNE** mode (instantaneous power) is selected.

DELV – Delivered (FWD – REFL) power

SWR - Computed SWR value for single needle meters. For Crossneedle meters, the SWR is indicates at the intersection of the FWD and the REFL needles when the **TUNE** mode is selected.

MIN-MAX Parameters – These options allow you to display the Min or Max values acquired by the Min/Max function on the Panel Meter. When you select the Min**...** or Max**...** option from the Panel Meter menu, the min or max parameter that will be displayed is the parameter that has been selected with the Min/Max menu.

The following shows the mapping for the MIN function based on the parameter selected for Min/Max processing using the Min/Max menu. The mapping for the MAX function is the same with the word "**MAX"** replacing "**MIN"**.

MINSWR – Minimum SWR
MINTUN – Minimum Instantaneous (TUNE) Power
MINTUF – Minimum (TUNE) Power with filtering
(see notes in section 3.13)
MINAVG – Minimum Average Power
MINPK – Minimum Peak Power
MINREF – Minimum Reflected Power
MINDEL – Minimum Delivered Power
MINOFF – Min/Max function is off

Note: PK-DEL, **REFL**, **DEL, SWR** are not valid for RF ammeter couplers or Generic Meter couplers. These options will be automatically skipped for these coupler types.

Field 3 – Displays the current range. Pressing M3 disables the AutoRange function if on, and sequences through each of the manual power ranges (if a power measurement is currently being displayed) or through each of the manual SWR ranges (if an SWR measurement is currently being displayed).

Choices:

All of the ranges defined during Panel Meter Calibration are available for selection from this menu.

Panel Meter Shortcut Button Functions:

Long Push of **Autrng** - will toggle the panel meter AutoRange function on and off. An asterisk next to the range in field 3 of the Panel Meter menu indicates that the AutoRange function is on and is automatically controlling the range. The lowest range that does not result in an out-of-range reading is selected by the AutoRange function.

LED Indicators for Panel Meter Shortcut Button:

Green LED – When the green LED on the **PanMtr** shortcut button is lit, this indicates that the Panel Meter AutoRange function is on.

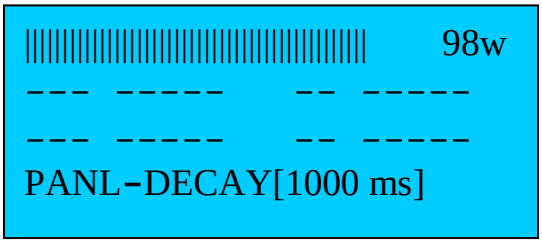
Yellow LED – When the yellow LED on the **PanMtr** shortcut button is lit, this indicates that the Panel Meter is in an overrange condition. (This will typically happen when you have selected a manual range).

3.15 Panel Meter Decay Time Setup

Function: Sets the panel meter decay time (the time delay before the panel meter "downranges" when switching to a lower range) ***when the Panel Meter is in the AutoRange mode***. To prevent the meter needle(s) from rapidly "hunting" between ranges for a quickly varying signal, the AutoRange function will hold the meter in a higher range than would be indicated by the instantaneous value for a user-defined time limit before down-ranging. This time interval is known as the Panel Meter Decay time.

To Activate Menu: Press the UP or DOWN menu button until the Panel Meter Decay menu is displayed as shown below.

Panel Meter Decay Menu



Field 1 – Displays current Panel Meter Decay time.

Example: PANL-DECAY[1000 ms] – Decay time is currently set to 1 second.

Choices: Panel Meter Decay time can be adjusted from .1 secs to 9.9 secs.

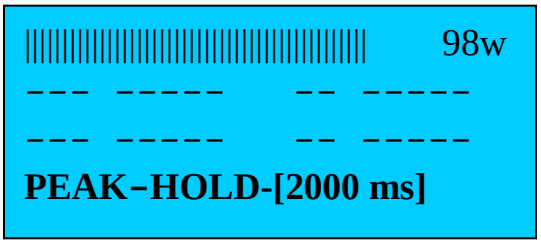
To change the Panel Meter Decay time: When the above menu is displayed, press M1 or the **Set-Up** Shortcut Button. This will bring up the setup screen. Adjust the front panel pot to the desired setting. Then press SAVE M1.

3.16 Peak Hold Time Setup

Function: Sets the peak hold time. This is a global setting. The peak hold time is used by all the display devices when they are displaying Peak power. The duration of the Bar Graph's sticky bar is also controlled by this value when the sticky bar is enabled.

To Activate Menu: Press the UP or DOWN scroll button until the Peak Hold delay menu is displayed as shown below.

Peak Hold Menu



Field 1 – Displays current Peak Hold Time

Example: PEAK-HOLD[2000 ms] – Peak hold time is currently set to 2 seconds.

Choices: Peak Hold can be adjusted from .1 secs to 9.9 secs.

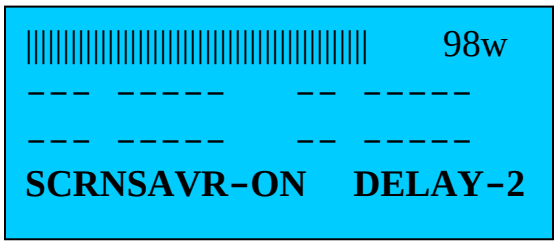
To change the Peak Hold time: When the above menu is displayed, press M1 or the **Set-Up** Shortcut Button. This will bring up the setup screen. Adjust the front panel pot to the desired setting. Then hit SAVE M1.

3.17 Screensaver

Function: Turns the Screensaver on and off, and controls the amount of idle time, in minutes, that must elapse with no activity before the screensaver activates. When the screensaver is enabled, the LCD display and the internal 7-segment displays will dim to a lower brightness level after the specified interval of inactivity.

To Activate Menu: Press the UP or DOWN menu button until the Screensaver Menu is displayed as shown below.

Screensaver Menu



Example: SCRNSAVR-ON DELAY-2
Screensaver is on. Delay is set to two minutes.

Field 1 – Displays the state of the screensaver.

Choices:

ON

OFF

Field 2 – Displays the Screensaver delay in minutes.

Choices:

1 – 9 minutes

Screensaver Shortcut Button Functions:

A ***Long Push*** of the M3 will toggle the screensaver on/off.

LED Indicators for Screensaver:

Yellow LED **-** The yellow LED on M3 is lit when the Screensaver is disabled.

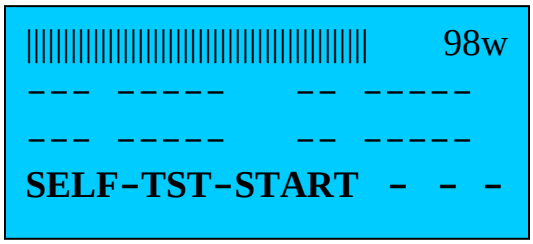
Notes: There may be some cases where you may want to temporarily disable the screensaver – for example to monitor long term min/max values that the meter is capturing even though there is no active signal present. Unless you have a special need of the kind described above, it is recommended that you keep the screensaver enabled.

3.18 Self Test Routines

Function: This menu initiates the interactive self test routines, which run diagnostics on the meter hardware. If you run into a problem with any of the self-tests, troubleshooting procedures are found here.

To Activate Menu: Press the UP or DOWN menu button until the Self Test menu is displayed as shown below.

Self Test Menu



Field 1 –Push M1 to start the self test routines.

Self Tests are run in the following sequence. You will either be prompted to "**PUSH ANY MENU KEY**" (M1 – M4) at the end of each test, or to select the EXIT menu choice to advance to the next test.

1. **Processor** - This test verifies that the main processor is operating properly.

- The processor and memory are tested.
- The sounder emits a beep for 300 ms.
- The alarm relay is operated twice for 500 ms.
- Each switch LED is lit in sequence for 300 ms.

The software then advances automatically to the Front Panel Switch test described below.

2. **Front Panel Switch Test** – This test verifies that the font panel switches are working properly.

   When prompted, press each front panel switch and verify that the press is detected and confirmed via a message on the LCD. If no activity is detected for 10 seconds, or if the Panel Meter shortcut button **PanMtr** is pressed three times (as a way to quickly exit this test without waiting for the 10 second timeout), the switch test will terminate and advance to the next self-test sequence.

   Switches are identified by number in the LCD confirmation message when pushed during the test. The function-to-number mapping is given in the table below:

Table 10- Switch Number-to-Switch Function Mapping

Pushed Switch	Confirmation Number Displayed on LCD
Top Row of Switches **Down/Scroll** through **Display/Setup** (7 switches) Left to Right	1 - 7
Bottom Row of Switches **PanMtr** through **ALARM** (6 switches) Left to Right (***Do not press the Power button***)	8 - 13

3. **Panel Meter test** – This test verifies that the Panel Meter driver circuitry is operating properly.

   An output is applied to each Panel Meter port in sequence. You should see needle deflection (not necessarily full scale) on all analog meters connected to a panel meter port output ***even if the Panel Meter Port has not been calibrated***. Make sure that none of the six Panel Meter trim pots are adjusted to their min (CCW) setting (which would result in an output of 0 volts to the Panel Meter).

4. **Seven Segment Display Test** – This test verifies that the internal and external seven segment displays (if connected) are operating properly.

   Numerals are written to all 7-segment displays including the external display devices. If the meter is configured for one external 7-segment display and the external Bar Graph (the factory default settings), only the external 7-segment display plugged into the ***Ext 1 Connector*** on the rear panel will be exercised to during this test (see **Table 20**).

5. **External Bar Graph** - This test verifies that the circuitry that drives the external bar graph module (if configured) is operating properly.

   The external Bar Graph is exercised. For the external Bar Graph to be exercised during this test, the meter must be configured for one external 7-segment display and the external Bar Graph (see **Table 20**). In addition, the external Bar Graph must be plugged into the ***Ext 2 Connector*** on the rear panel. This test is skipped automatically by the software if the meter is configured for two external 7-segment displays (and no external Bar Graph).

6. **RS-232 Test 1 - MB-1 Transmit Test** – This test verifies that MB-1 can properly send data to the PC.

   You must be running a terminal emulation program, such as TeraTerm on your PC with the following options:

   Baud rate = 115,200
   Data = 8 bit
   Parity = None
   Stop Bits = 1
   Flow Control = none

   MB-1 repeatedly transmits a test message to the PC ("MB-1 Test Message"). This should be seen on your PC screen in the terminal emulation window.

   If you do not have a terminal emulator set up at this time, you can skip this test. However, it is recommended that you run this test before updating the firmware or before backing up the EEProm with the included utilities, since those utilities rely on proper two way communication with your PC.

7. **RS-232 Test 2 - MB-1 Receive Test** – This test verifies that MB-1 can properly receive data sent to it from the PC.

   You must be running a terminal emulation program such as TeraTerm on your PC (see section 10). The software prompts you, via a message on the LCD, ***to type a lower case 'a' from the PC keyboard***. If the software successfully receives that character, an "OK" message will be displayed on the LCD. If ten seconds elapse without successfully receiving the expected character, an error message will be displayed on the LCD, and the next self test sequence will be entered. **Note, before typing the character from the PC, make sure that the terminal emulation program is the active window on your PC (i.e., click your mouse on the TeraTerm window before typing in the character 'a'.)**

   If you do not have a terminal emulator set up at this time, you can skip this test. However, it is recommended that you run this test before updating the firmware or before backing up the EEProm with the included utilities, since those utilities rely on proper two way communication with your PC.

8. **Front Panel High Precision Pot** – This test verifies that the front panel pot and associated A-to-D input circuitry are working properly.

   As the pot is turned, its relative rotation (1 – 100) will be displayed on one of the internal 7-Segment display modules.

9. **Coupler Port Test** – This test verifies that the Programmable Gain Amplifier and A-to-D circuitry that processes the coupler input signals are operating properly.

   Apply a voltage from a test connector (e.g., from the 200 uA jack on rear panel) to each of the eight coupler input ports one at a time. When a signal is detected on a coupler input port, the piezo transducer will generate a pulsing tone, and a message will be displayed on the LCD to indicate the coupler port on which the input signal is being detected. For example:

   SIG DET ON COUP 2
   ON FWD PORT

   Make sure that none of the eight coupler trim pots (right side of the case) are set at their minimum CCW positions. If you are running the self test diagnostics as part of the post assembly process, the pots should have been preset to reasonable settings during the assembly process.

   If you are not running these diagnostics as part of the post assembly process, do not disturb the settings on any of the trim pots, since this will undo your Coupler or Panel Meter calibration.

   If the top of the case is off for any reason (e.g., you are running the self tests as part of the post assembly process), do not touch any of the leads on the rear of the RCA jacks with your fingers during this test since this may register as a false "coupler detected" signal.

   Keep in mind that it is possible (but highly unlikely) that the trim pot of a previously calibrated coupler port is too low to provide an adequate signal to exceed the established threshold for the coupler self test. Again, this is not likely, but is something to keep in mind if the self test on one of the coupler port inputs fails.

Notes: If any of these tests fail, consult the schematic in the MB-1 Circuit Description document to aid in isolating the problem.

10. **Testing the Alarm Relay Contacts** - You will hear the alarm relay operate at the beginning of the Self Test as described in step 1. This confirms that the relay is operating. To test the actual alarm relay contact use the following approach. Connect an ohmmeter or continuity tester to the four combinations of N/O- Common, N/C – Common jack connections one at a time testing for continuity between the N/O – common contacts while the relay is operated, or testing for breaking of the N/C - common contacts while the relay is operated. Measure between the center conductors (tip) of the associated RCA jacks. You will have to cycle the Self Test four times to test all fours contact pairs since the relay operates only briefly.

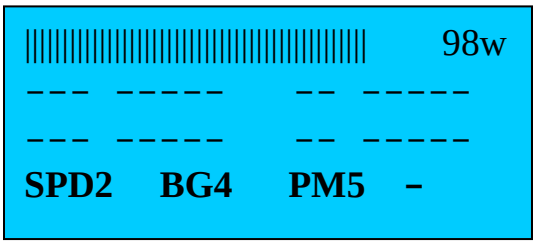
    The easiest way to do this is to first save the SELF-TEST menu as the startup menu by selecting the SELF-TEST menu on line 4 and saving it to the startup set (long push of M1). Set up your continuity tester between the contact pair being tested. (Remember – the ground connections on the RCA jacks are not involved in this test – only the center contacts.) Start the Self Test sequence by pushing M1. After you have confirmed that the first contact pair is working, simply power down the meter so that you do not have to cycle through the entire Self Test again. Connect you continuity tester to the next pair of contacts to be tested. Power up the meter. Since the Self-Test menu will be the active menu after power up, simply press M1 again to repeat the self test sequence. This will allow you test for proper operation of the second contact pair. Repeat this power-down self test sequence until you have tested all four contact pairs. Powering off the meter in the middle of the Self Test sequence will not cause any harm.

3.19 Speed (Adjust Display Update Rates)

Function: Sets the rate at which the various display devices are updated.

To Activate Menu: Press the UP or DOWN menu button until the Speed menu is displayed on line 4 as shown below.

Speed Menu



Example: SPD2 BG4 PM5 -

Speed of numeric display devices (LDC numeric values and 7-segment devices) is set to a relative speed of 2.

Speed of bar graph display is set to a relative speed of 4.

Speed of panel meter is set to a relative speed of 5.

Field 1 – Numeric Display Speed – controls update rate of LCD numeric displays and 7-Segment LED modules, including the external 7-segment modules.

Choices: 1 – 9

Field 2 – Bar Graph Display Speed – controls update rate of the Bar Graph on the LCD as well as the external Bar Graph module.

Choices: 1 – 9

Field 3 – Panel Meter Display Speed – controls update rate of the selected Analog Meter.

Choices: 1 – 9

To change the display device update rates: Press M1, M2, or M3 to change the speed of the numeric (LCD and 7-segment) displays, the Bar Graph, and Panel Meter respectively.

Notes: The speed menu controls the nominal update rates for the various display devices. However, you may sometimes see the update rate temporarily increase above its nominal value on one or more of the display devices. This is by design. For example, when going from a "no power" condition to a "power on" condition, whenever a new peak value is detected, or whenever a new SWR value is acquired, the display associated with that measurement is updated immediately instead of waiting for the next scheduled update display cycle. This provides a real time response for these measurements even when the display update rate is set to a low value.

3.19.1 Performance Metrics

Function: Displays the number of measurement cycles per second and the number of Bar Graph updates per second that the software is currently processing. The ability to monitor the meter's performance was a tool that was used during the software development cycle, but you may find this tool useful as well. It can be used to see what the performance impact is of processing various measurements, activating the various display devices, and modifying the display update rates.

To View the performance metrics, activate the SPEED menu on line 4 of the LCD as shown above). Then Push the **DISP** button. The performance metrics will be displayed on the LCD. To exit, press the Display button again.

Sample Display - Performance Metrics

```
METER UPDATE RATE=
430 MEAS/SEC
BAR GRAPH UPDATE=
62 PER SEC
```

Notes – The performance metrics run at a low priority and require approximately 10 seconds between snapshots to acquire valid data. If you request the data too soon after making a prior request, the message **NOT READY** will be displayed.

To minimize the impact these metrics have on the meter's performance, a low resolution timer is used to capture the performance data. This results in a somewhat reduced accuracy of approximately ± 10%.

For the most accurate results, select the SPEED menu. Then wait approximately 10 seconds ***without pressing any other buttons during that interval.*** Then press the **DISP** button. Processing any button routines immediately prior to displaying the performance data will result in lower values.

4 Miscellaneous

4.1 Loading Special Configuration Settings at Startup

There are some configuration settings that can only be changed while powering up the meter using certain combination of menu buttons. This is discussed in this section.

4.1.1 Reset to Factory defaults

This step must be performed once after assembly to initialize the software. It can also be run subsequently to place the meter back in its default state. ***To return all settings to their factory settings***, first turn power off. Then, while pressing both M1 and M2, turn power on. Hold both buttons until the **WAIT** confirmation message appears on the LCD.

Caution: This will overwrite the coupler tables, reloading them with the default OEM tables (e.g., Coupler 1 = MB-HF1 calibration table). Therefore, if you modified or otherwise changed the coupler tables for couplers 1-4, this operation will overwrite your data.

This action will not erase any Panel Meter calibration tables or any user-defined configuration sets. The startup set will be set to the Default configuration set, but the user-defined startup settings are still intact. If you wish restore your original startup settings after performing this initialization step, do the following:

Apply a medium press to the Backup button. (This loads the user-defined Start Up set into memory). Now save these settings into the Start Up set (with a long push of M1). Your original startup settings have now been restored, and will loaded each time you power-up the meter.

This operation will not preload the internal Panel Meter calibration table that was shipped with the meter. Nor will it erase it. If you need to recalibrate the internal Panel Meter for any reason, the procedure is described in 8.6.

This initialization operation also loads the LCD with the special character set used by the software to generate the LCD Bar Graph. This is required only once after kit assembly is complete. However, if the LCD is ever replaced, this initialization operation can be used to reload the special LCD character set.

4.1.2 Reloading Preset Coupler Settings

To reload ***all*** of the coupler presets (factory coupler settings) for couplers 1 - 4 while leaving all other settings intact, first turn power off. Then, while pressing both M3 and M4, turn power on. Hold both buttons until you see the **WAIT** confirmation message on the LCD. This will load the calibration tables for Coupler 1 – Coupler 4. ***This operation will overwrite the current coupler settings*** and will take several seconds. All other settings are not affected.

If you wish to selectively load only some of these couplers, see section 5.3.1 on loading the Quick Setup Coupler profiles.

Note – this operation affects the coupler tables only, and has no impact on the Panel Meter calibration tables.

4.1.3 Configuring the Hi-Visibility Configuration for one 7-Segment Displays and One Bar Graph

To configure the external display ports to drive ***one external 7-segment display and one external bar graph module,*** first turn power off. Then, while pressing M3 only, turn power on. Hold the button until you see the **WAIT** confirmation message on the LCD. (This setting is the default factory setting for the external display devices).

4.1.4 Configuring the Hi-Visibility Configuration for Two 7-Segment Displays

To configure the external display ports to drive ***two external 7-segment displays (no external bar graph module)***, first turn power off. Then, while pressing M4 only, turn power on. Hold M4 until you see the **WAIT** confirmation message. (Note – the Expansion Kit includes one external 7-segment display module.)

A summary of these special startup configurations is given in **Table 20**.

4.2 Disabling the Screensaver

Long Push of M3 **-** Toggles the screensaver on and off. There may be some cases where you may want to temporarily disable the screensaver – for example to monitor long term min/max values that the meter is capturing, even when no active signal is present. However, please be aware that running the meter continuously with the screensaver disabled consumes more power, and will may reduce the life of the LCD (although I have not encountered this with continuous operation with the screen saver disabled). If you have disabled the screensaver, apply another long push to M3 to re-enable it. The yellow LED on switch M3 is illuminated when the Screensaver is disabled.

4.3 Display of Large Numbers (>= 10,000)

MB-1 can display values up to 30,000. In order to display values greater than or equal to 10,000, the following convention is used:

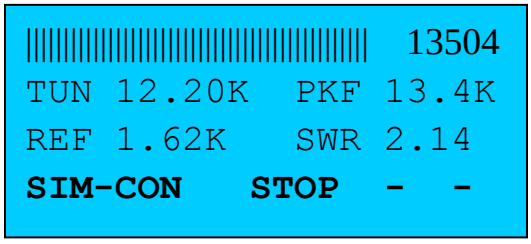
7-Segment Displays:
A 4-digit 7-segment display module can normally display a maximum value of 9999. To handle larger values, ***the decimal point on the least significant digit will be lit to*** indicate that a value >= 10,000 is being displayed. In this mode, the value is displayed is in "kilo" units. For example, a power display of

12.24.

on a 7-segment module would indicate a value of 12.24 kilowatts. This convention applies to all values being displayed on the 7-segment modules, including Generic Meter applications.

LCD Display:
Since the LCD supports alphanumeric characters, the Suffix 'K' (kilo) is appended to numeric values (instead of the 'w' character) when the reading is greater than or equal to 10,000. For example, a FWD instantaneous power of 12,200 watts, a peak power value of 13,400 watts, and a reflected power value of 1,620 watts, would be displayed on the LCD as shown below:

Note: While the MB-1 is capable of measuring values somewhat larger than 30,000, the software will limit all displayed values to 30,000.



4.4 Exiting Display Mode and Setup Mode

As described earlier, a short push of the DISPLAY/SETUP button displays the current settings for the currently selected menu. A long push of the DISPLAY/SETUP button enters the setup mode allowing you to make changes for parameters associated with the current menu.

Some of the display and setup operations do not have an explicit exit option. The following explains how to easily exit the Display or Setup modes without affecting any settings if you enter one of these setup modes by mistake.

To Exit the Display Mode: The Display functions are read-only, so there is never a risk of unintentionally modifying any of the settings in the Display mode. If you inadvertently enter the Display mode, simply apply short presses to the Display button to sequence through each of the display screens. When you get to the last display page, the next push will cause the meter to exit the display mode and resume normal operation.

To Exit the Setup Mode: If you inadvertently enter a Setup mode that has no exit option, press M3 repeatedly. M3 corresponds to the **SKIP** option on most setup screens, ***which keeps the current setting***, and advances to the next option. After all options have been "skipped", the meter will return to normal operation.

If you ever accidentally modify a setting, you can, of course, enter the Setup mode again to change it back, but it is likely that one of the configuration sets has the settings you desire. In this case, simply restore the desired configuration set.

4.5 Some Comments on SWR Measurements

SSB SWR Stabilizer Function

SWR is one of the more difficult parameters to measure accurately, especially in the presence of time varying signals. MB-1 employs digital filters to address this problem. The software monitors the digital filter results to determine when an accurate and stable calculation has been acquired. This 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.

"SWR Changing" Indicator

MB-1 allows you to monitor the quality of the current SWR value being displayed. An unstable SWR is usually the result of a true time varying SWR of the load (for example, when adjusting an antenna tuner, or hot switching antennas).

The green LED on the DISPLAY/SETUP switch (top right switch) will illuminate when the software determines that the SWR is changing, and that a stable SWR ***value has not yet been acquired.*** This generally 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, and should provide a reasonable measurement for most real world operating conditions (e.g., SWRs in the range 1 - 4).

The "SWR Changing" indicator may flicker occasionally, especially for time varying signals such as SSB. This is normal, and is the result of a compromise between the filter accuracy and response time. In most cases, once the true SWR of the load is stable, and remains stable, the MB-1 algorithms will lock on to a stable calculation and display the SWR value in a fraction of a second.

The "SWR Changing" indicator can be turned ON or OFF from the Averaging Filter menu as described in section 3.2. You may view this as more of a developer tool, but we left it in the product (defaulted to OFF). If you are curious about this feature, feel free to experiment with it.

SWR Accuracy vs. SWR

You may notice that the stability of the SWR reading is better at lower SWR values than at higher SWR values. This has to do with the formula for SWR and the sensitivity to errors as a function of SWR. To summarize, a given error in the measurement process for a low SWR will produce a smaller error in the SWR value than if the same size error is introduced at a higher value SWR. Another way of saying this is that once the SWR reaches a value of 3 or 4, its numerical value rises very rapidly as the SWR further degrades. To see this, examine the chart below.

The Blue data series is the SWR as a function of reflected voltage. For this example, the Forward voltage is held constant at 100 units, and the Reflected voltage is varied from 0 (perfect SWR) to 90 units (SWR of 19).

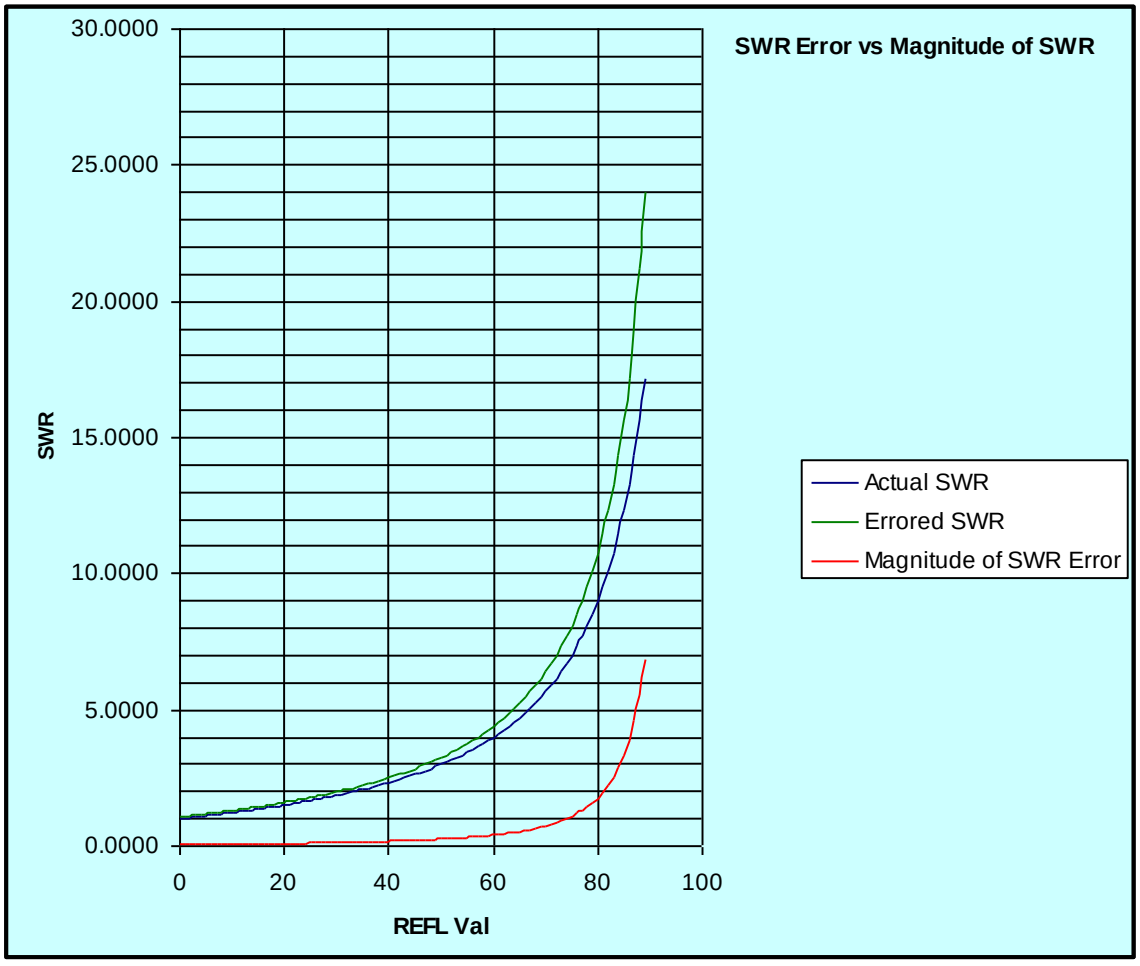
The Green series shows the SWR that is calculated when we introduce an error into the calculation (thereby simulating an error in the measurement process due to noise or A-to-D

quantizing). For purposes of an example, we introduce an error of 3 counts (we add 3 counts) to ***each*** digital representation of reflected value and then repeat the calculation to arrive at the errored SWR curve (in green).

The Red series shows the difference between the Green series (errored SWR) and the Blue series (ideal SWR). As can be seen, the error in the SWR calculation introduced for SWRs less than 3 is relatively small (the error in the errored SWR curve is only .25 SWR units when the SWR = 3), and is even smaller for lower SWRs). When we introduce the same error (3 counts) at higher SWRs, the magnitude of the error is larger. For example, when the actual SWR is 10.0, the errored SWR when the same error (3 counts) is introduced into the measurement process is approximately 2.2 SWR units higher.

Most stations will operate within a reasonable SWR range, but if you are putting the meter through its paces and you see less stability at the higher SWR values, this is the reason.

Figure 11 - Magnitude of SWR Error vs. SWR



5 Coupler Calibration

5.1 Overview

You can use MB-1 with minimal setup since the calibration settings for the included MB-HF1 coupler are preloaded to the Coupler port 1 table. You only need to adjust the Coupler 1 FWD and REFL side panel trim pots at a single power point using either a multimeter or external reference power meter. (See section 6 for details.)

Coupler ports 2 - 4 are also preloaded with ***Quick Setup Profiles*** that you can use with minimal setup with other couplers you may have around the shack. The Profiles are described in more detail below. Most Bruene-type directional couplers that use diode detectors and that generate FWD and REFL DC voltages can be used with MB-1.

In addition to the preloaded presets, you can also configure any of the four coupler ports as follows:

- Load a Quick Setup Profile into a coupler port. There are 21 Quick Setup Profiles to choose from (described in section 5.3.1).
- Perform a multi-point custom Calibration on a coupler port.

The Quick Setup Profiles are very easy to use, but with the exception of the ***OEM settings 1-20, which all contain the multipoint calibration table for the included MB-HF1 coupler***, all other Quick Setup profiles are ***single point*** calibration tables of different sensitivities. (Currently unused OEM codes 2 – 20 are all loaded with the MB-HF1 coupler table as a placeholder until new OEM codes are assigned.) The wide range of provided sensitivities for the single point calibration tables should be able to accommodate most couplers.

When using Quick Setup Profiles for use with power couplers, you will set the coupler trim pots at one point using a reference meter. The coupler will be very accurate at (and around) that one point. The overall accuracy for the rest of the range will be determined by how accurately the coupler adheres to the square law relationship between applied power and the DC voltage generated by the coupler.

In the case of an RF ammeter or Generic Meter Application, the accuracy will be determined by the linearity of the coupler or input device (since RF ammeter and Generic Meter Applications assume a linear input/output relationship). Again, the advantage of using the Quick Setup Profiles is ease of use. ***However***, i***f you have an accurate reference meter, you will always obtain the best accuracy using the multipoint (custom) calibration procedure described in section 5.4***

5.2 Reloading the Factory Coupler Settings

If you wish to reload the coupler factory settings at any time (this will not affect the other meter settings or Panel Meter calibration tables), use the following procedure:

First turn power off. Then, while pressing both M3 and M4, turn on power. Hold both buttons until you see the **WAIT** confirmation message. This will load the calibration tables for Coupler 1

– Coupler 4 as per the table below. ***Note - this operation will overwrite any existing calibration tables for these couplers. You can repeat this operation at any time.***

Table 11- Coupler Factory Presets for Couplers 1 - 4

Coupler Number	Full Scale Power
1	MB-HF1 Coupler Presets - 2000 watts FS , 15 Calibration points
2	Quick Setup – high sensitivity
3	Quick Setup – medium sensitivity
4	Quick Setup – low sensitivity

5.3 Quick Setup Profiles

5.3.1 Quick Setup Couplers – Overview

Most of the ***Quick Setup Profiles*** are single point calibration tables that should work reasonably well with a variety of power couplers and RF Ammeter couplers. If you are setting up a Generic Meter application whose input is truly linear, you should be able to achieve a high degree of accuracy with a Quick Setup Profile.

Quick Setup Couplers are selected by choosing an OEM code during the coupler setup procedure. OEM code 1 is the calibration table for the MB-HF1 coupler provided with MB-1. OEM codes 2 – 20, as listed in **Table 12**, are reserved for future use. All OEM codes in the range 2 – 20 in **Table 12** that are not currently assigned are loaded by default with the MB-1 calibration table. As MeterBuilder supports additional OEM codes (new MeterBuilder couplers and possibly other manufacturers' couplers), the calibration tables for these couplers will be made available on the MeterBuilder website for download. After downloading the latest set of OEM calibration tables, the OEM update utility described in section 3.11 can be used to update the OEM section of MB-1's EEPROM, thereby allowing all supported OEM couplers to be loaded into working couplers 1 – 4 simply by specifying the OEM code during the coupler setup routine.

Quick Setup Coupler **OEM codes 21 – 30** correspond to ***single point*** calibration tables for RF Power couplers, with ***code 21 being the least sensitive***, and ***code 30 being the most sensitive***. (The sensitivity you choose will be a function of how much voltage your power coupler or other input device generates for the range of interest. Couplers that generate a large output voltage for the measurement range of interest will require a less sensitive setting, and vice versa. ***These OEM codes (21 – 30) are intended for power coupler applications, and use a square law mapping between input and output.***

Quick Setup Coupler OEM codes **31 – 40** are intended for use with RF Ammeter couplers (or for use with analog sensor applications) that have a linear input-to-output relationship, with ***code 31***

being the least sensitive, and ***code 40 being the most sensitive***. ***Again, these OEM codes (31 – 40) use a linear mapping between input and output.***

Note that OEM codes 21- 40 all use single point calibration tables.

The full scale values listed in **Table 12** and **Table 13** below serve only to specify the full scale value that will be ***used when one of the real coupler ports (1-4) that is loaded with the associated OEM value is run using the Demo mode feature***. For actual coupler operation, the specified measurement will be displayed when the coupler (or input device) applies approximately 6.14 volts to the FWD coupler port input (with the side panel adjustment pot turned to its maximum CW travel (maximum sensitivity)). (Note, a voltage higher than this with the trim pot set to its most sensitive (max CW) position will result in saturation.

Measure the full scale DC voltage of the power coupler or other input device you plan to use. If the voltage is less than 6.14 volts at full scale, pick a more sensitive OEM code than the one indicated for the full scale value.

If the voltage is higher than 6.14 volts, pick the scale most closely corresponding to the full scale reading you want to obtain. With a more sensitive OEM code, at full scale, your coupler (or other input device) will saturate when the coupler sensitivity pot set to its maximum, so you will have to back off the sensitivity on the side panel coupler trim pot until no saturation (limiting) occurs.

Some trial and error may be required here. But the goal is straightforward - to pick the most sensitive OEM setting ***that provides an in-range reading without saturating*** when the sensitivity pot on the side panel is adjusted close to its maximum CW (most sensitive) travel. This will provide good resolution and accuracy without causing saturating of the Amplifier/Mux.

Table 12 - Coupler Presets and OEM Codes for Power Couplers

(Square Law Relationship)

OEM Code	Full Scale Value (Power)	Approx DC input voltage required at FWD port to achieve Full Scale value (sensitivity pot at max CW position)	DC Voltage at various Power Points (This allows trim pot setup using a DC multimeter)	Description
Multipoint OEM Calibration Tables				
1	2000 watts	6.14 volts	P=50w, P=100w, (Voltages are printed on benchmark label on MB-HF1 coupler)	MB-HF1 Coupler Calibration Table
2 -7 with standard 16 KB EEPROM **2 – 20** with 32 KB EEPROM provided with Expansion Kit	-	-		Reserved for Future Use. OEM Codes currently not assigned default to the MB-HF1 calibration table. Standard MB-1 EEPROM supports 7 OEM calibration Tables (OEM codes 1 – 7). Expansion Kit EEPROM supports 20 OEM calibration Tables (OEM codes 1 – 20).
Quick Setup (Single Point) Calibration Tables for Power Couplers (Square Law Mapping between Input and Output)				
21	20 watts	6.14 volts	NA	Quick Setup – Sensitivity 1 (Lowest sensitivity)
22	100 watts	6.14 volts	NA	Quick Setup – Sensitivity 2
23	200 watts	6.14 volts	NA	Quick Setup – Sensitivity 3
24	500 watts	6.14 volts	NA	Quick Setup – Sensitivity 4
25	1000 watts	6.14 volts	NA	Quick Setup – Sensitivity 5
26	2000 watts	6.14 volts	NA	Quick Setup – Sensitivity 6
27	5000 watts	6.14 volts	NA	Quick Setup – Sensitivity 7
28	10000	6.14 volts	NA	Quick Setup –

	watts			Sensitivity 8
29	20000 watts	6.14 volts	NA	Quick Setup – Sensitivity 9
30	30000 watts	6.14 volts	NA	Quick Setup – Sensitivity 10 (Highest sensitivity)

Table 13 -
Coupler Presets and OEM Codes for RF Ammeters and Generic Meter Applications
(Linear Law Relationship)

OEM Number	Full Scale Value (amps for RF Ammeter, or user-specified units for Generic Meter Applications)	Approx DC input voltage required at FWD port to achieve Full Scale value (sensitivity trim pot at max CW position)	Description
Quick Setup (Single Point) Calibration Tables for RF Ammeter Couplers or Generic Meter Inputs (Linear Mapping between Input and Output)			
31	1	6.14 volts	Quick Setup – Sensitivity 1 (Lowest sensitivity)
32	5	6.14 volts	Quick Setup – Sensitivity 2
33	10	6.14 volts	Quick Setup – Sensitivity 3
34	20	6.14 volts	Quick Setup – Sensitivity 4
35	30	6.14 volts	Quick Setup – Sensitivity 5
36	50	6.14 volts	Quick Setup – Sensitivity 6
37	100	6.14 volts	Quick Setup – Sensitivity 7
38	200	6.14 volts	Quick Setup – Sensitivity 8
39	500	6.14 volts	Quick Setup – Sensitivity 9
40	1000	6.14 volts	Quick Setup – Sensitivity 10 (Highest sensitivity)

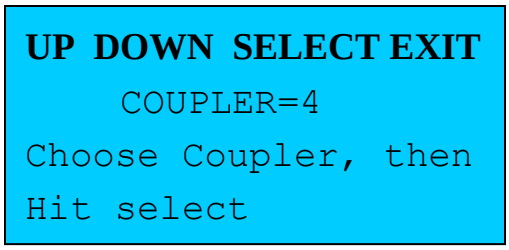
Note: For RF current (ammeter), a full scale value of up to 30 amps can be chosen but is probably higher than you will need since 30 amps corresponds to an output power of 45 kilowatts into a 50 ohm resistive load.

5.3.2 Coupler Calibration using Quick Setup Profiles (OEM Setting)

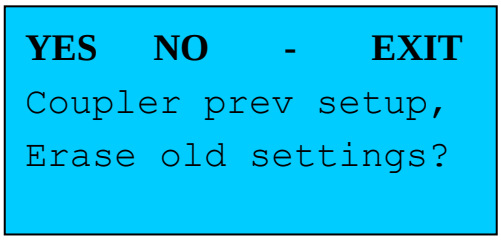
This section describes how to load a Quick Setup profile into a coupler.

To start the calibration, bring up the Coupler menu (**COUP**). Then press **Set-Up**. The following shows the setup screens. In the screens below, you will be asked to enter an OEM code. Select the OEM codes from **Table 12** or **Table 13**.

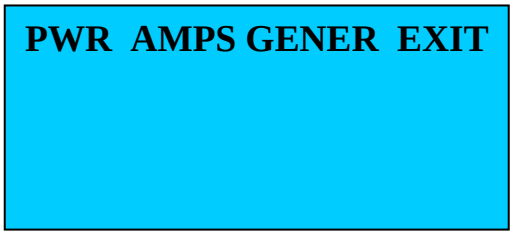
1. **Selecting Coupler** with the **UP/DOWN** button.



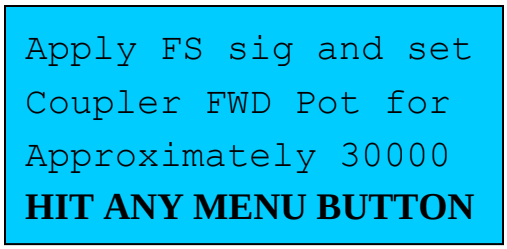
2. Optional prompt to erase settings of a previous calibration.



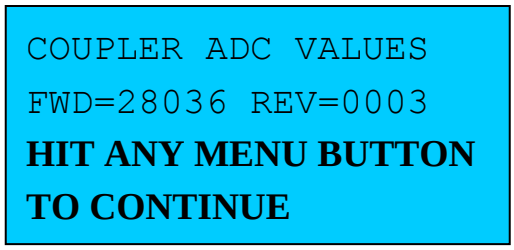
3. **Prompt to select Coupler Type:** Select **Power Coupler, Ammeter Coupler, or Generic Coupler** with menu buttons M1, M2, or M3. In this example, we chose Power (M1).



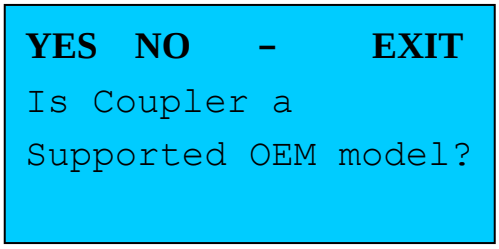
4. **Prompt for Side Panel Pot Adjustment**: Hit menu button to proceed with adjustment. This provides (close to) maximum sensitivity without saturating the amplifier/A-D chain.



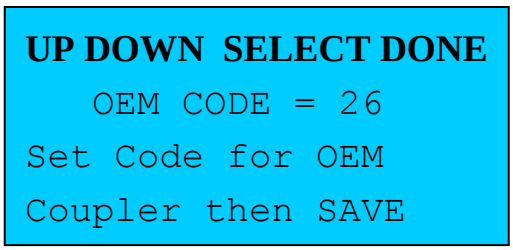
5. **ADC values when FWD sensitivity pot properly adjusted. (An exact setting of 30,000 (FWD) is not required, but this reading should be 30,000 or less. Otherwise you run the risk of saturating.)**



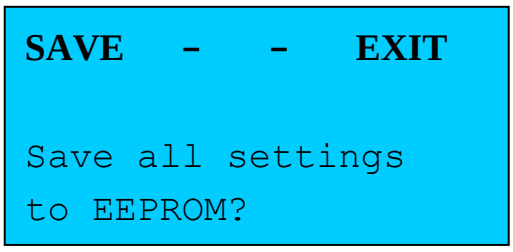
6. **Prompt to determine if coupler is to use OEM code** (which will use a Quick Setup Profile)



7. **Prompt to Select OEM code** (see Table 12 and Table 13). The OEM values you should select will be determined by the coupler you are using as previously described (1 – 30 for Power Couplers, 31 – 40 for RF Ammeter and Generic couplers). Select the OEM code with the UP/DWN buttons. Then press SELECT.



8. **Prompt to Save Settings to EEPROM**



In the above example, we have configured Coupler 4 for a single point ***Quick Setup Profile*** to measure power. We have chosen OEM code 26, which is a medium sensitivity setting.

5.4 Multipoint (Custom) Coupler Calibration - Overview

Custom coupler calibration allows you to calibrate a coupler ***at multiple power levels and multiple frequencies***. This calibration procedure provides the maximum accuracy over both the power and frequency range. RF Ammeter couplers and Generic Meter Applications may also be calibrated at multiple points.

The MB-1 software makes use of as little or as much data as you provide during the calibration (from a single point, to as many as all 60 points) to calculate the measurements values. MB-1 also supports editing of a previously calibrated coupler table, allowing you to add more calibration points without redoing the entire calibration, or to correct one or more calibration points if the need arises.

For most power couplers, calibration at the following power levels will do a very good job: 0.5 watts, 1 watt, 5 watts, 10 watts, 50 watts, 100 watts, 500 watts, 1000 watts. In fact, depending upon your coupler, a single point may work well. A single point calibration table is effectively what the Quick Setup Profiles are (see section 5.3).

The advantage of the calibration edit function is that you can start out with just a couple of points, and then determine power levels where the accuracy could use some improvement. You can then go back into the calibration routine and add additional calibration points at those power levels.

The following table lists the available calibration power levels for the Main (reference) band:

Table 14- Power Points for Main (Reference Band) Calibration

0[1]	3 watts	40 watts	200 watts	1200 watts	4000 watts
0.05 watts	4 watts	50 watts	300 watts	1300 watts	5000 watts
0.1 watts	5 watts	60 watts	400 watts	1400 watts	6000 watts
0.2 watts	6 watts	70 watts	500 watts	1500 watts	7000 watts
0.3 watts	7 watts	80 watts	600 watts	1600 watts	8000 watts
0.5 watts	8 watts	90 watts	700 watts	1700 watts	9000 watts
0.6 watts	9 watts	100 watts	800 watts	1800 watts	10000 watts
0.8 watts	10 watts	125 watts	900 watts	1900 watts	15000 watts
1.0 watt	20 watts	150 watts	1000 watts	2000 watts	20000 watts
2.0 watts	30 watts	175 watts	1100 watts	3000 watts	30000 watts

[1] Calibration Point 0 is for use with Analog sensors only.

The following describes the steps for calibrating a power coupler. Although intended for use with couplers other than the one provided with MB-HF1, you can calibrate the MB-HF1 coupler with this procedure to familiarize yourself with the steps. (Perform the calibration using coupler ports 2 – 4 if you want to keep the MB-HF1 calibration table that is loaded into coupler port 1 undisturbed).

Calibration of an RF Ammeter coupler and Generic Meter application are very similar to the RF power coupler procedure described here. The primary difference is that there is no reflected DC port in the ammeter and Generic Meter applications to deal with. In addition, the frequency band compensation steps that apply to RF power couplers do not apply to the latter two coupler types.

The following provides an overview of the coupler calibration steps followed by the detailed setup screens.

1. An external reference meter or other calibration device should be connected in tandem with the coupler to be calibrated, and the combination should be fed into a suitable 50 ohm resistive dummy load.

2. During calibration, you will have to enter the following information:

- The coupler type (Power, RF Ammeter, or Generic Meter). Select Power.

- The full scale value that you want the coupler to operate at. This is a physical limitation of the power handling capability of the coupler. You can always choose a full scale value ***lower than the coupler's power rating*** if it meets your needs. In fact, if you have a coupler rated at 2000 watts, and you never intend to operate above 500 watts, choose a FS setting of 500 watts during calibration. This will provide a slight improvement in resolution and accuracy.

- The ***Reference Band*** (160 mtrs – 70 cm). ***This is the band that you will do the forward power calibration on*** (think of this as the primary calibration table). The frequency compensation algorithm will use these reference band calibration points and calibration points at up to nine power levels on each of the other bands to perform correction during each power calculation when a band other than the reference band is selected using the Band menu. 80 meters is a good choice for the reference band if you use that band.

3. You then adjust the side panel FWD port trim pot for the associated coupler. This is done by applying the expected full scale power to the coupler, and then adjusting the FWD port pot for a reading close to the maximum full scale output of the Amplifier/A-to-D converter chain in MB-1. The point here is to achieve maximum sensitivity without saturating. This is done by setting the pot to a value of approximately 30,000 as read by MB-1 and displayed on the LCD on one of the setup screens when the full scale signal is applied. (Note, the max value of the amp/A-to-D pair is 32,736. You don't want to get too close to this max value. Otherwise you run the risk of saturating). You will only be able to reach this maximum value if your coupler (or other input device) can generate at least 6 volts. If that is not the case, simply adjust the trim pot to its maximum CW (most sensitive) setting. This will ensure maximum resolution for the device you are using the drive MB-1.

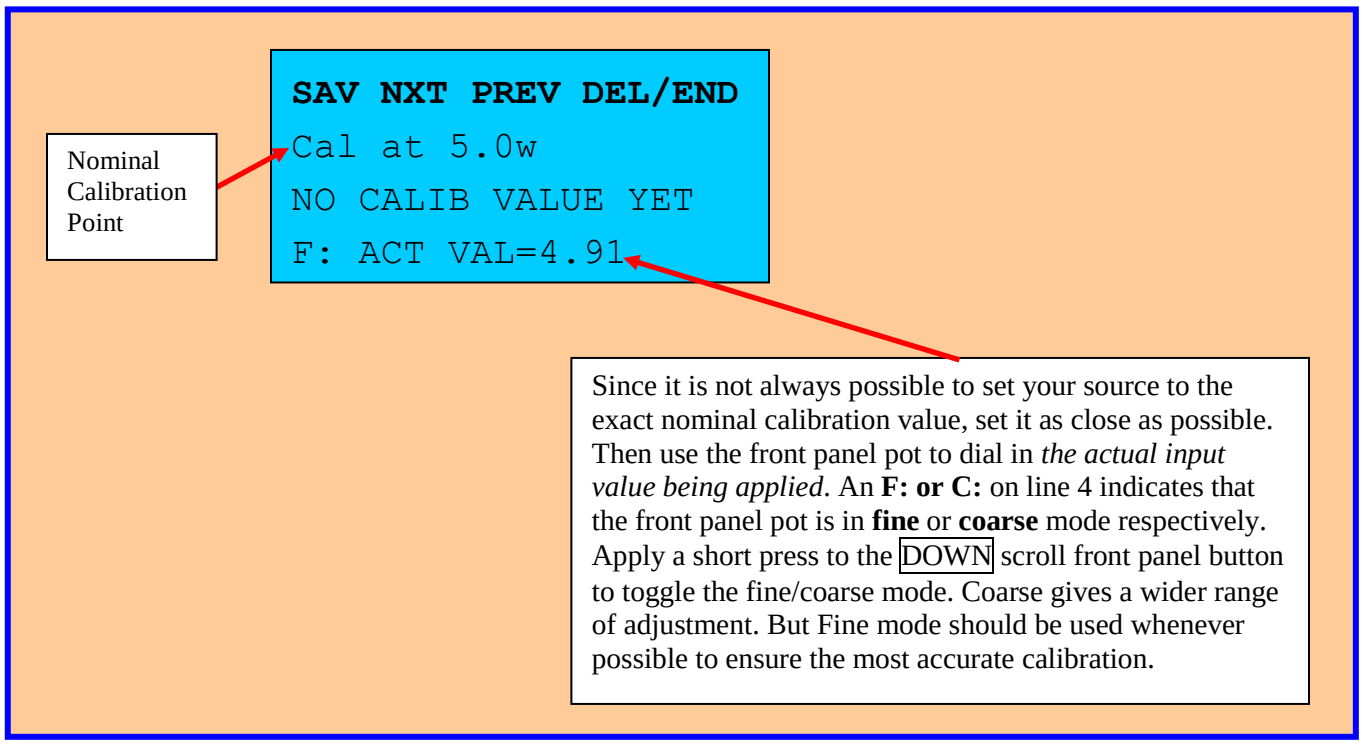
   If you current equipment (e.g., transceiver) can not apply power at the level corresponding to the full scale value you want to program the coupler for, the detailed steps below explain how to perform the side panel pot adjustment at a lower level. This assumes that the coupler or other input device being used to drive MB-1 is capable of generating 6 volts or more at full scale. If that is not the case, simply turn the trim pot to its maximum CW (most sensitive) position as discussed above.

   Caution: If you set the coupler trim pot incorrectly and overdrive the MCP6S28 Amplifier/Mux chip causing any of its 8 input leads to exceed the maxim chip rating of 5.3 volts, this can cause a form of crosstalk allowing an signal on an unselected input lead to "crosstalk" to the multiplexer output even though that input lead is not selected by the software. Following the above procedure in this step will prevent this condition from occurring. See the FAQ Troubleshooting section for more detail.

4. You then step through each of the 60 available calibration points, stopping at the ones you want to load. At each point that you choose, you adjust the power source of your transmitter to the nominal value for that calibration point, as verified using the external reference meter in series with MB-1. Since it is sometimes difficult to apply the exact nominal power, MB-1 provides an adjustment, using the high resolution front panel pot, for each calibration point so that you can specify the ***actual*** power that is being applied.

For example, assume that you are performing calibration at the 5 watt calibration point. Assume that the closest output that can be achieved with your equipment is 4.91 watts as displayed by the reference meter. In this case, even though the nominal calibration point is 5 watts, ***you would dial in that actual power of 4.91 watts with the front panel pot*** before saving that calibration point. The software will then calculate the calibration data for the nominal calibration point ***by correcting the recorded ADC calibration value based on the nominal calibration power and the actual calibration power.*** This results in a much more accurate calibration table. This is illustrated in the sample screen below:

Calibration Screen



5. Once calibration is performed at all the points of interest, you are given the option of running the band correction calibration. It is recommended that you skip this step initially. You can edit the coupler table later to add the band correction data. The edit function also allows you to modify one or more forward power points (the reference band calibration) without rerunning the entire calibration sequence if the need arises.

6. When prompted to save the settings, you have the option to save the settings to EEProm or to EXIT. Exiting will leave any previously performed calibration data for the current coupler intact. If you save the data, it is saved in EEProm, and will be recalled for use by the meter software any time this coupler is selected via the Coupler menu.

7. If desired, after you completely exit the calibration sequence, you can view a summary of the new calibration settings you just performed by pressing the **DISP** shortcut button and

stepping through the calibration data screens with multiple pushes of the **DISP** button.

8. After calibration is performed on the FWD port and saved in EEPROM as described above, make sure that the transmit source is not transmitting any power. Swap the PL-259 connectors on the coupler. ***This will cause the FWD power applied by the transmitter to be measured by the coupler's REFL port.*** The reflected channel calibration is performed solely with the REFL coupler trim pot on the right side of the case as described below.

   When adjusting the REFL coupler trim pot, you must first enable the Reflected Channel Calibration" mode. Do this with a long press of the M2 button. The Yellow LED on the M2 button will flash repeatedly to remind you that you are in the Reflected Channel Calibration" mode. Note – when in this mode, disregard all readings except the REFL power reading, which will be adjusted using the trim pot.

   Apply a nominal power (for example 50 watts as measured using a reference meter).

   Adjust the reflected coupler trim pot for the coupler port being adjusted ***until the Reflected Power displayed on MB-1*** agrees with the known power level being applied. Make sure that the Constant Signal indicator (green LED on M1) is lit before deeming the adjustment complete to make sure the REFL power reading has stabilized (since very long time constants are used by the software during the calibration procedure).

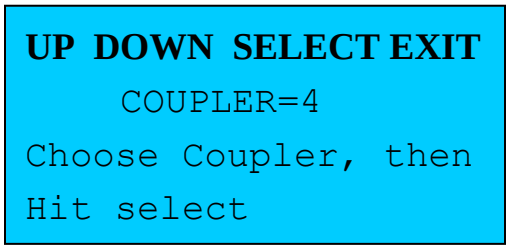
   After you are done adjusting the REFL coupler trim pot, turn the Reflected Channel Calibration mode off with a long press of the M2 button. The flashing yellow LED on the M2 button will go off to confirm that you have exited the Reflected Channel Calibration mode.

9. Any time after coupler calibration is complete, an optional "Trim" operation can be performed on all the FWD power calibration points at once using the procedure defined in 3.8.2. The trim function is useful if you want to "tweak" the entire FWD calibration curve for any reason.

5.5 Custom Coupler Calibration – Detailed Steps

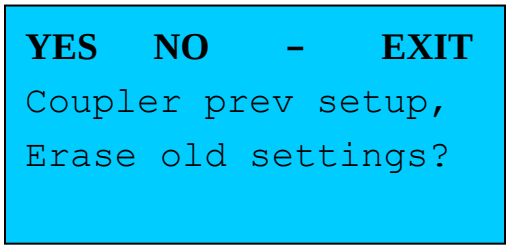
The following shows most of the LCD screens that you will see when performing multipoint (custom) calibration. To start calibration, select the coupler menu (**COUP**). Then go into setup by pushing the **Set-Up** button.

1. **Selecting Coupler** with the **UP/DOWN** button.

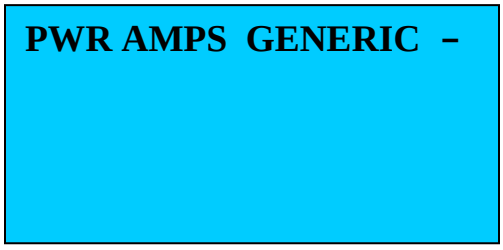


Important: To prevent unintended erasing of the wrong coupler, make sure you select the correct coupler number during this step. If you make an error and select the wrong coupler, simply press EXIT on the first available screen that has an EXIT option.

2. **Prompt to erase settings** if the current coupler was previously calibrated. You would chose **NO** if you wanted to EDIT an existing set of calibration values. Otherwise, enter YES to erase the previous settings.



3. **Prompt to select Coupler Type:** Select **Power Coupler, RF Ammeter Coupler, or Generic Application** with menu keys M1, M2, or M3 respectively.



4. **Prompt for Side Panel Pot Adjustment**: Prompt to adjust sensitivity of side panel FWD coupler pot. Hit menu button to display actual ADC values.

```
Apply FS sig and set
Coupler FWD Pot for
Approximately 30000
HIT ANY MENU BUTTON
```

Side Panel Pot Adjustment: If your equipment can not apply the desired full scale power during calibration, use the following procedure to determine how to adjust the side panel sensitivity pot:

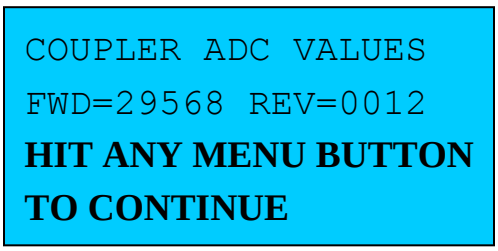
Assume that you want to set the coupler for a full scale value of 1000 watts. Assume that the transmitter you are using can put out a little over 500 watts. In that case, apply 500 watts, as determined by the reference meter). Since the input/output relationship for a power coupler is a square law relationship, set the FWD pot for approximately

$$30000 * \sqrt{Applied / FS} = 30000 * \sqrt{500/1000} = 21200$$

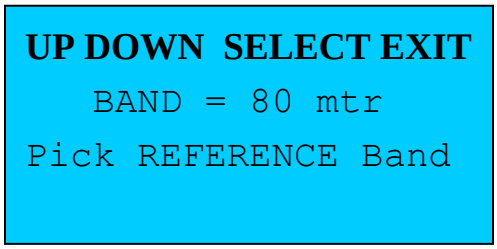
For an RF Ammeter or Generic Meter Application, you may have the same problem (assume you want to calibrate an RF ammeter for 5 amps Full Scale, but your transmitter is capable of outputting only 2 amps). In that case, apply 2 amps, as determined by the reference RF ammeter (or power meter). Since the input/output relationship for a power coupler is a linear relationship, set the FWD pot for approximately

$$30000 * (Applied / FS) = 30000 * (2/5) = 12000$$

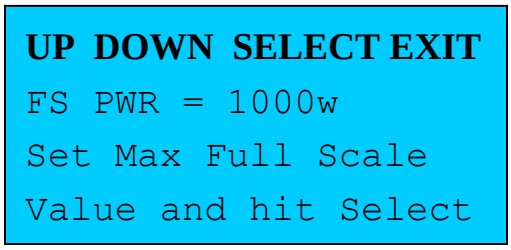
Note – For Power Couplers: if the coupler you are using has a lower sensitivity on the Reflected Power port than on the FWD Power port, and you have maxed out the FWD coupler port pot to maximum CW sensitivity in an attempt to get as close to the ADC 30000 count (or the value indicated using the above formula), you may find that you when you attempt to calibrate the reflected channel, that you cannot reach the desired reflected channel power measurement, even at full CW travel of the REFL trim pot. Keep this in mind before you start the calibration. If you have such a situation, you should crank down the FWD trim pot somewhat before doing the calibration. This, in effect, will provide you with an internal calibration table with higher sensitivity, which will then allow you to achieve a higher reflected power reading during reflected channel calibration.



5. **Select Reference Band.** This is the band you will do your forward power calibration on. 80 meters is a good choice if you use that band. This step is bypassed automatically if you are calibrating an RF ammeter coupler or Generic Meter application.

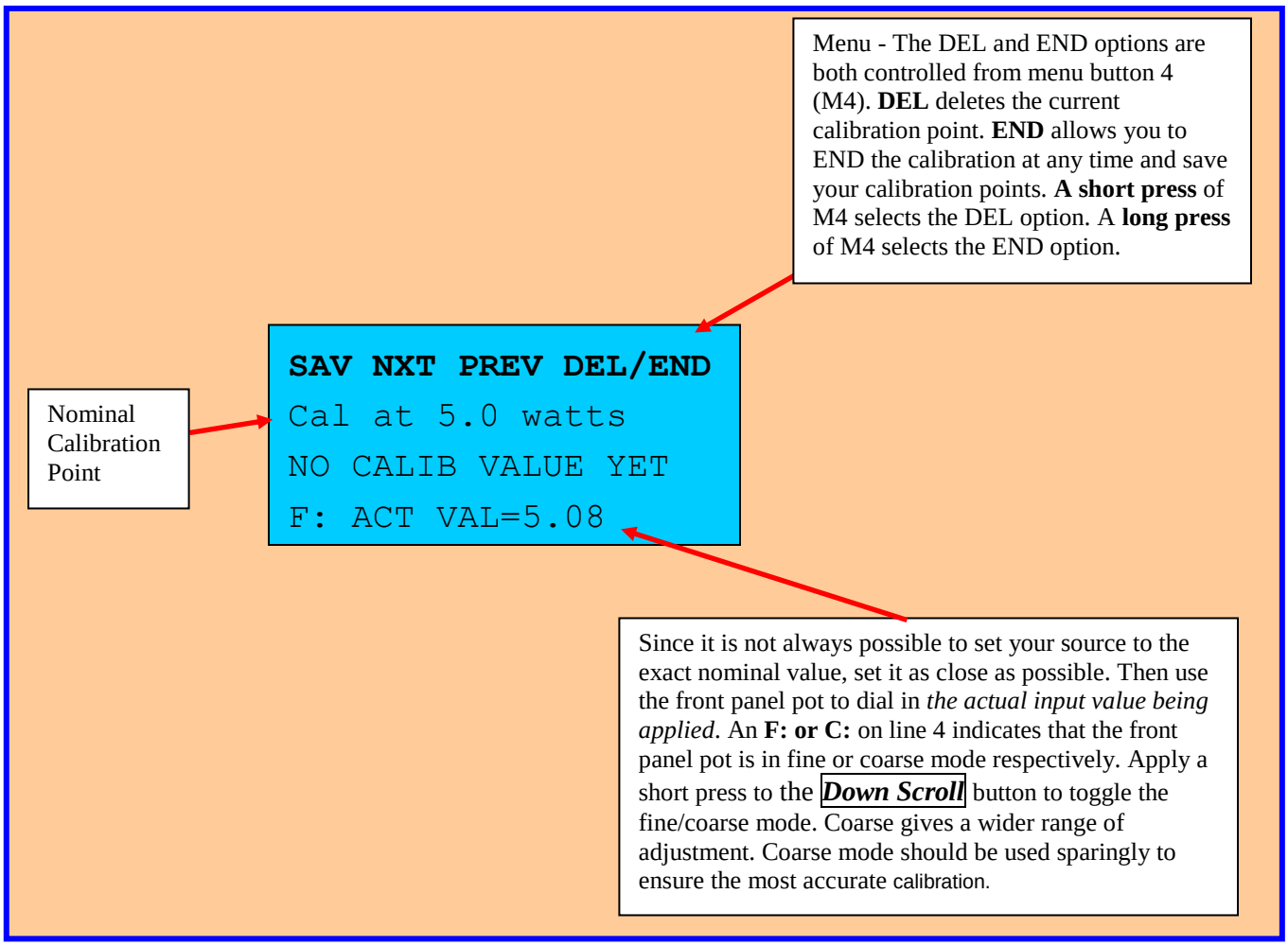


6. **Set the desired Maximum Full Scale Power** using **UP/DOWN** buttons. This setting controls the range of power calibration points you will be prompted for during calibration. This information is also used by the built-in simulator so that it can simulate the correct full scale power for this coupler when used by the Demo mode feature.



7. **Actual Calibration** – Repeat the following step for each selected calibration point (at least one calibration point is required for the software to consider the calibration valid). See Figure 12 below.

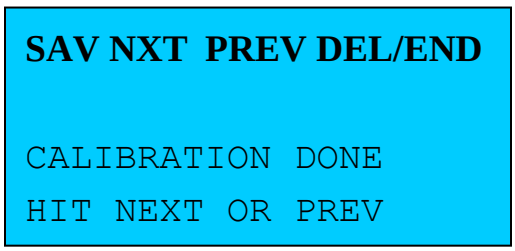
Figure 12 – Calibration Screen



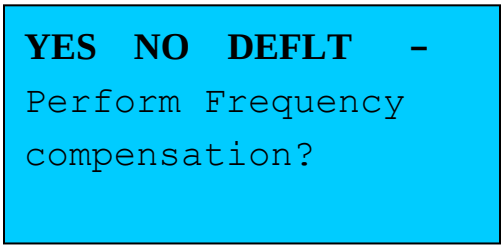
8. **NEXT/PREV Prompt** - After calibrating the last available point (which is determined by the full scale value you chose in an earlier step), you will be prompted to Hit **NXT** to Proceed. This prompt is included simply to give you a chance to go back to a **PREV**ious point, if desired when you are at the last calibration point.

   Note - It is not necessary to align all available points within the range you selected, and it is not a requirement to calibrate the last (full scale) point. ***You can press END (long press of M4) at any time once you have entered all of the points you wish to calibrate. This will terminate the current calibration session without prompting you for any additional points.*** You will then be presented with the option to save the available calibration data to EEProm.

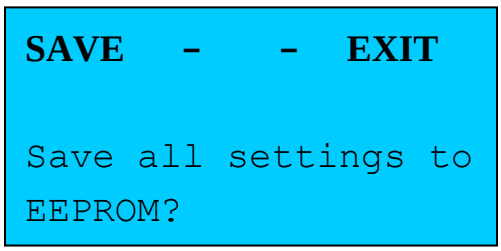
   At Last Point – Hit NEXT to Proceed



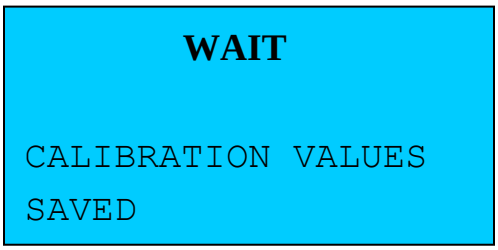
9. **Optional Band Calibration** - (Described separately below). Until you are comfortable with the basic calibration sequence, it is recommended that you skip the Band Calibration steps (by pressing **NO**). You can perform band calibration later using the EDIT function.



10. **Save Settings**



11. **Settings Saved** – Confirmation. Meter returns to operating mode.



5.6 Generic Meter Calibration Example – Detailed Steps

Prior to performing a custom calibration on a Power Coupler, you may want to first run through the generic meter calibration described in this section since this is the simplest type of custom calibration, and will better acquaint you with the general procedure.

In this example, we will implement a 0 – 5 volt voltmeter using the Generic Meter feature. No physical coupler is required in this case. All we need to do is connect the voltage that we wish to

measure with our sample application to the coupler's FWD port). We will use the 5 volt source (from the +5V jack on the rear panel of MB-1) as our calibration reference. Caution – the +5v jacks are connected directly to one of the 5 volt power busses and are protected against shorts only by the main meter fuse connected to the 12 volt input.

For the actual calibration, you can assume that the auxiliary 5 volt source on the rear panel RCA jacks is exactly 5.00 volts. Or you can measure the voltage with an independent voltmeter and use that value during the calibration sequence. Remember that the calibration functions have been programmed to account for the fact that it may be difficult to apply an exact input at a given calibration point, and therefore, the calibration routine always allows you to input the actual input that was used for calibration (which, in this case, would be the value you measured the independent voltmeter). Using this information, the calibration routine will then correct the calibration constant before storing it in EEPROM.

Steps:

1. Connect the 5 volt source +5V jack to the Coupler 4 FWD Port with an RCA Cable as shown below:

Figure 13 – Connecting 5v Input to Calibrate the Generic Meter Example

2. Bring up the Coupler menu on line 4 of the LCD.

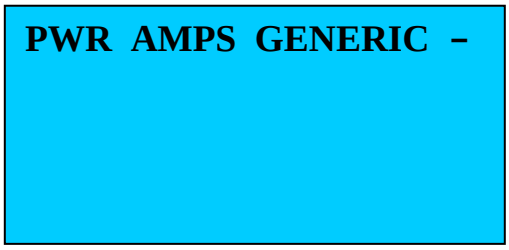
3. Press the **Set-Up** button (long press).

4. If coupler 4 is not already selected, push the UP or DOWN menu keys **to select coupler 4**. Then select that coupler by pressing M3 (**SELECT**).

```
UP DOWN  SELECT EXIT
     COUPLER=4
Choose Coupler, then
Hit select
```

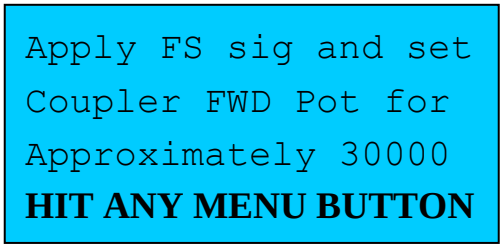
5. If coupler 4 was previously setup, you will be asked if you want to erase settings. Press YES (M1) if you receive this prompt.

6. You will be prompted to enter the type of coupler you are setting up. Select **Generic** Meter (M3).

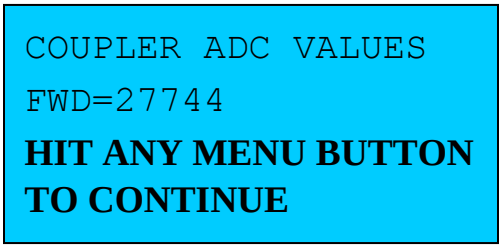


7. Since we are creating a voltmeter function, select the units "V" or "v" for "volts" by dialing the front panel pot to select the desired character, and then press M1 (SAVE). ***All upper case and lower case letters are available for selection (except 'a', which is reserved for use with RF ammeter couplers)***. The "units" character that you select here will be appended to the measurement values displayed on the LCD.

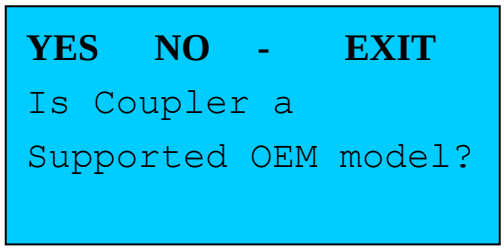
8. You will then be asked to adjust the Coupler 4 FWD port side panel trim pot on the right side of the meter. Make sure an RCA cable is connected between the +5V jack and the FWD port of coupler 4 as shown in Figure 13. With the ADC values being displayed on the LCD, adjust the Coupler 4 FWD pot for a FWD ADC reading, as displayed on the LCD. Ideally, you want this value to be approximately 30,000, as displayed on the LCD. But in this case, you will not be able to achieve this high a value because the input is lower than the 6.14 volts required to drive the amp/ADC chain to its maximum value. When you encounter a case like this, simply adjust the side panel pot for the maximum attainable value (full CW position of side panel pot – 15 turns or more CW). Note – The 15 turn coupler adjustment pots have no stops



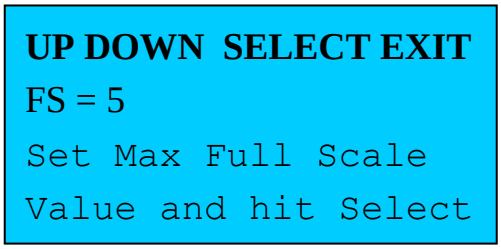
9. Screen showing proper alignment of side panel pot (side panel coupler trim pot at max CW position in this example).



10. You are asked if you want to use an OEM (Quick Setup) setting. Since the purpose of this exercise is a custom calibration, answer No (M2).



11. Set the Full Scale Value to 5 volts using the UP/DOWN buttons. Then save that choice by pressing SELECT (M3).



12. You will now be prompted for the individual calibration points. The Generic Meter provides a linear mapping of input voltage to display values. Since this particular Generic Application is linear (the applied voltage and the parameter being measured are one in the same), we need to calibrate at only a single point. Push **NXT** repeatedly, skipping all calibration points until the calibration point of 5.0 is presented as shown in **Figure 14** below.

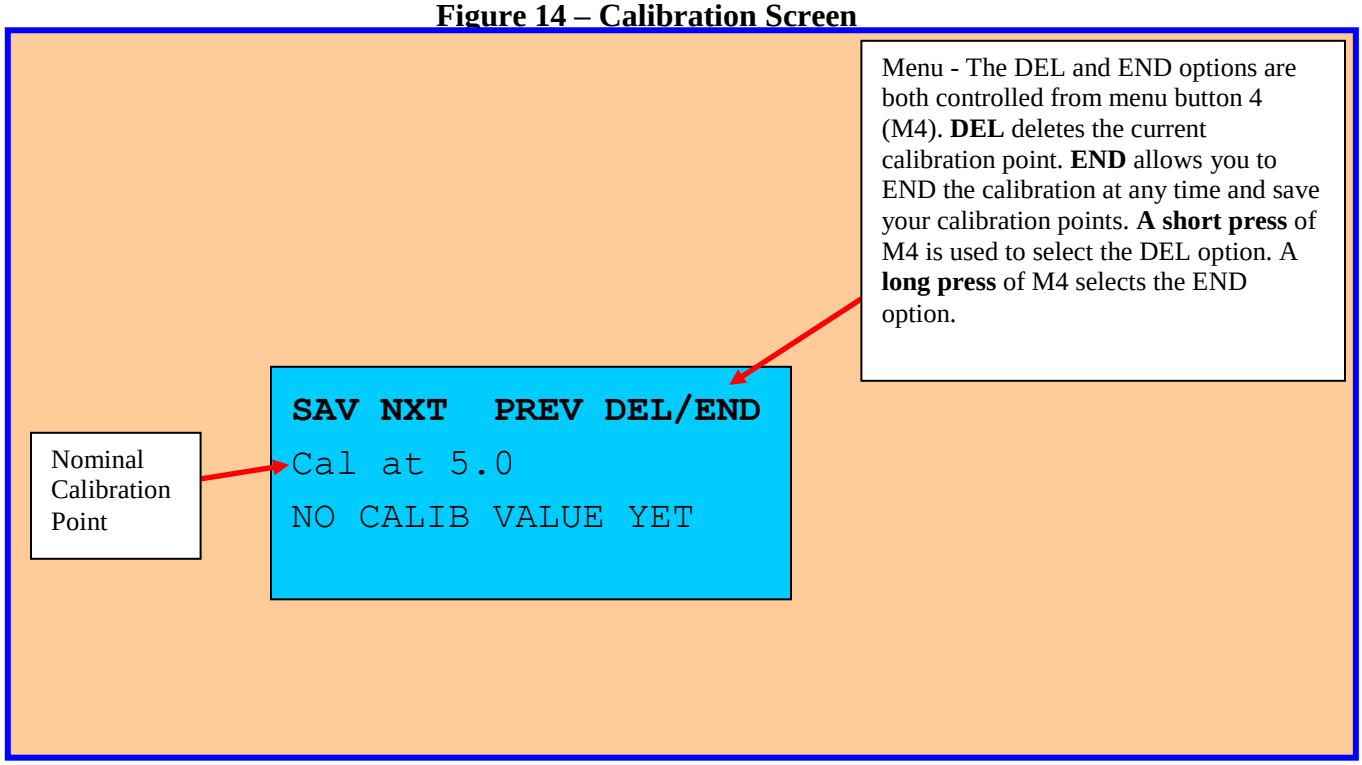
13. The voltage at the +5V RCA jack may not be exactly 5.0 volts. If you have measured the exact voltage with a separate voltmeter (it should be very close to 5.0 volts), you can dial to front panel pot until the **ACT VAL** entry on line 4 of the LCD, as shown in **Figure 14** below, matches the voltage you measured. Entering the exact applied input will always yield the best accuracy. For this exercise however, it is fine to assume that the voltage of the 5 volt bus is exactly 5.00 volts.

14. Press **SAVE** (M1) to save the calibration value.

15. If, when entering the **ACT VAL**, you need a larger range of adjustment then the full CCW or CW position of the front pot provides, press the DOWN scroll button (short press). This will cause F**:** (fine adjustment mode) **to change to C:** (coarse adjustment mode) **on line 4** (see Figure 14). This ***coarse*** adjustment mode allows you to dial in a wider range of the **ACT VAL** values with the front panel pot. (For this example, you will not need to make use of the coarse adjustment because the voltage from the rear RCA jacks should be very close to the nominal calibration point of 5.0 volts).

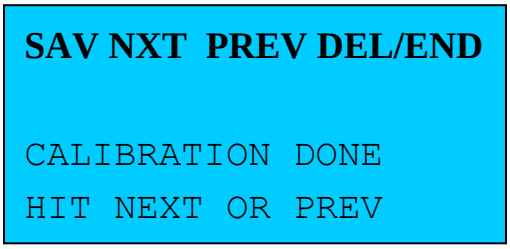
    The **DOWN** scroll button actually provides a toggle operation between Fine and Coarse modes, so you can switch between the **FINE** and **COARSE** modes with alternate short pushes of the **DOWN** button). Note, however, for multipoint calibrations, when you select the next calibration point, the mode automatically defaults to the FINE mode, which is the mode that should be used whenever possible to achieve the best calibration accuracy.

Figure 14 – Calibration Screen

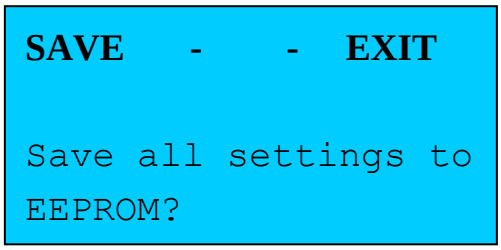


16. When you are at the last calibration point, the meter ***does not exit*** to the final SAVE screen automatically. This is done to allow you to hit the PREV button, if desired, so you can go back to a previous calibration point if desired. In our case, we are done entering the calibration data. Therefore, press NXT (M2) to proceed.

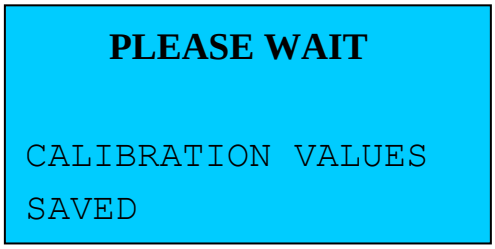
At Last Point – Hit NXT to Proceed



17. You will now be prompted to SAVE the settings to EEPROM. Hit SAVE (M1).



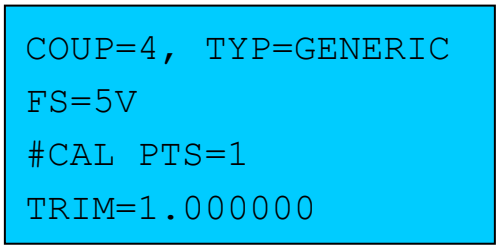
18. You will see a message confirming that the settings were saved. Calibration is now complete.

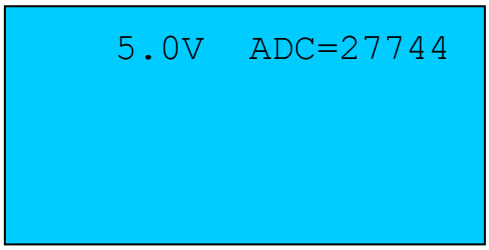


19. Using the **DISP** Function to View Settings

This step is optional. If you want to examine the settings for the Voltmeter calibration you have just performed, press the **DISP** button. This brings up the first screen of coupler settings. Continue to press **DISP** to view additional screens. After the final screen, the next push of the **DISP** button will return the meter to normal operation.

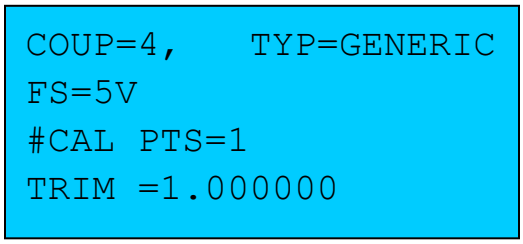
Examples of Display Screens for the "Generic Voltmeter" coupler port are shown below:

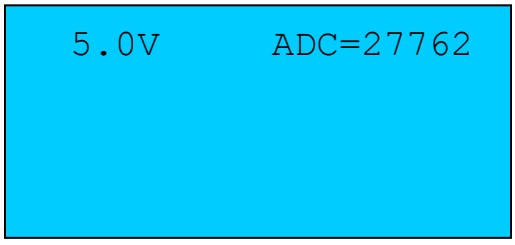




The first Display screen shows the key parameters such as the full scale value that we set during calibration (5 volts), the number of calibrations points (1), and the TRIM factor. The Trim factor defaults to 1.0 (see section 3.8.2).

The second Display screen shows the actual calibration points. In this case, we have only one. But for cases where we performed calibration at multiple points, the calibration data would be displayed for each point.

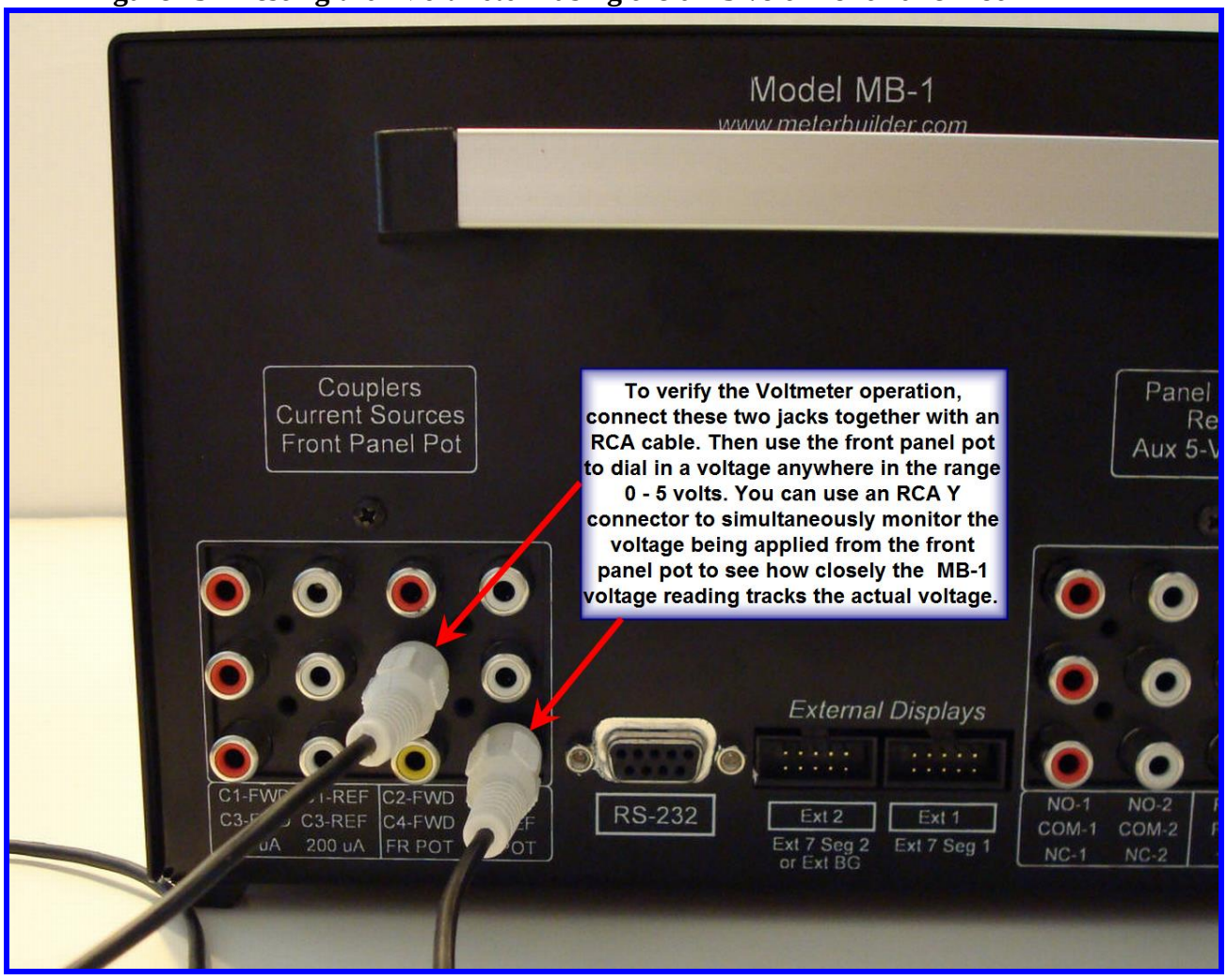




You now have a 0 – 5 volt voltmeter on the FWD port of coupler 4. To test it, connect one of the rear RCA jacks that is connected to the wiper of the front panel high precision pot (**FR PAN POT jack**) to the Coupler 4 FWD port with an RCA cable as shown in the figure below. Turn the front panel pot and verify that the display devices on the meter read between 0 volts and approximately 5.00 volts as the pot is turned from its minimum position (full CCW) to its maximum position (full CW). (There are some protection resistors on the **FR PAN POT** jacks, so your max voltage may be slightly less than 5.00 volts). You can always bridge on a separate

multimeter (e.g., using a Y connector) to check MB-1's accuracy.

Figure 15 - Testing the "Voltmeter" using the 0 – 5 volt Front Panel Pot



This Generic Meter example, which implemented a voltmeter function, can be used to measure parameters for a large variety of applications that generate a suitable DC voltage. In the above example, since we were building a voltmeter, our parameter (voltage) and input to the meter (voltage) are one in the same (100% linear). Therefore, a single calibration point was sufficient. However, if you have Generic Meter Application where the "parameter of interest" and the generated DC voltage are not a linear function, you can achieve a reasonable mapping by calibrating the "parameter of interest" at several points. Several Generic Meter examples are given in the Generic Meter User's Manual.

5.7 Editing a Previously Saved Calibration – Forward Power Example

You can edit one or more Coupler calibration points at any time without the need to repeat the entire calibration procedure, including the addition or modification of band calibration points for power couplers. For example, if your initial calibration was done barefoot at 100 watts maximum, and you have recently added an amp to your station that outputs 1200 watts, you can edit the calibration table to add calibration points at higher powers (e.g., 500 watts, 1000 watts). This will improve accuracy at these higher power levels. **Important – *you will not be able to edit power calibration points higher than The FS value you specified during the initial calibration set up*. That would require the complete calibration to be redone. Keep this in mind when you first set up the coupler** (i.e., When first setting up a coupler, ***specify the maximum full scale value you eventually intend to use***, even if you will not calibrating the coupler table at the power level during the initial calibration).

This section describes how to edit the ***Forward*** power calibration points of a power coupler. Editing the calibration points for an RF ammeter or generic coupler application is similar.

1. Bring up the Coupler Menu.

2. Press the **Set-Up** button.

3. Select the desired coupler number (1-4) with M1.

4. Since we are editing the FWD reference band calibration points in this exercise, select **FWD**. (If you wanted to perform band compensation at this time, you would select **FREQ** instead).

5. Hit NXT or PREV as required selecting the calibration point you wish to modify, add, or delete. Perform the same actions you did during the original calibration: Apply a signal at the nominal level using a reference device in series with MB-1. Then adjust the front panel pot to enter the ***actual*** applied level. Then hit SAVE.

   Repeat this step for any other points you want to add or modify. If you want to delete a previous calibration point (e.g., if one of your calibration points is inaccurate, and you wish to remove that point completely from the calibration table rather than recalibrate it), select that point with the NXT/PREV buttons. Then apply a short press to M4, which selects the DEL option of the dual menu function DEL/END.

6. When all desired points have been added, modified or deleted, apply a long press to the END button M4 (DEL/**END**) to terminate the calibration and to be offered the option to save the edited data.

7. You are now given the option to SAVE the modified settings to EEProm or to EXIT. Press SAVE. (If you pressed EXIT instead, any previous settings for this coupler port would be left intact).

8. After saving the data to EEProm, you have the option to TEST the coupler, or to EXIT. The TEST function simply reports the ADC values being measured by the amp/ADC chain at the forward and reflected ports to confirm that the coupler and meter input connections are intact. (For RF ammeter and Generic meters, only the FWD port ADC values are applicable).

9. Editing of the Reference Band is now complete.

5.8 Band Compensation:

Band Compensation is a bit more complex than the Reference Band calibration, but once you feel comfortable with the basic calibration, you will find that band compensation uses a similar approach to the basic (FWD) calibration. You may want to wait until you gain some familiarity with basic MB-1 calibration before undertaking this topic.

Overview:
You can perform band compensation as part of the normal Power Coupler calibration after you have finished forward power calibration on the Reference Band. You can also perform and EDIT function on a previously calibrated coupler to add or modify band compensation points. This is the recommended approach until you familiarize yourself with the calibration procedure.

For each band that you calibrate, you can add one to nine power calibration points. These calibration points are compared to their corresponding calibration points on the reference band to determine real time correction factors. ***After band calibration is performed, these correction factors are then applied to the input signal*** to calculate the actual power level for bands other than the Reference Band.

The power points you choose for band compensation on any of the non-reference bands ***must be power points that were previously calibrated on the Reference Band***. The available calibration power points for band compensation are:

Table 15- Power Points for Frequency Compensation

5 watts
50 watts
150 watts
500 watts
1000 watts
2000 watts
5000 watts
8000 watts
15000 watts

You do not need to compensate all bands. And for those bands that you do compensate, you can use anywhere from one power point to all nine power points. The software will examine the calibration tables each time you select a coupler, and make the best use of whatever data is a*vailable* to correct the power measurements.

Many couplers are fairly flat from 160 meters through 10 meters. In such a case, if you operate 160 meters – 6 meters, you may want to add a couple of compensation points on the 6 meter band only. You can always go back and edit the calibration settings at a later time to add more bands, or to add more power points to a previously calibrated band.

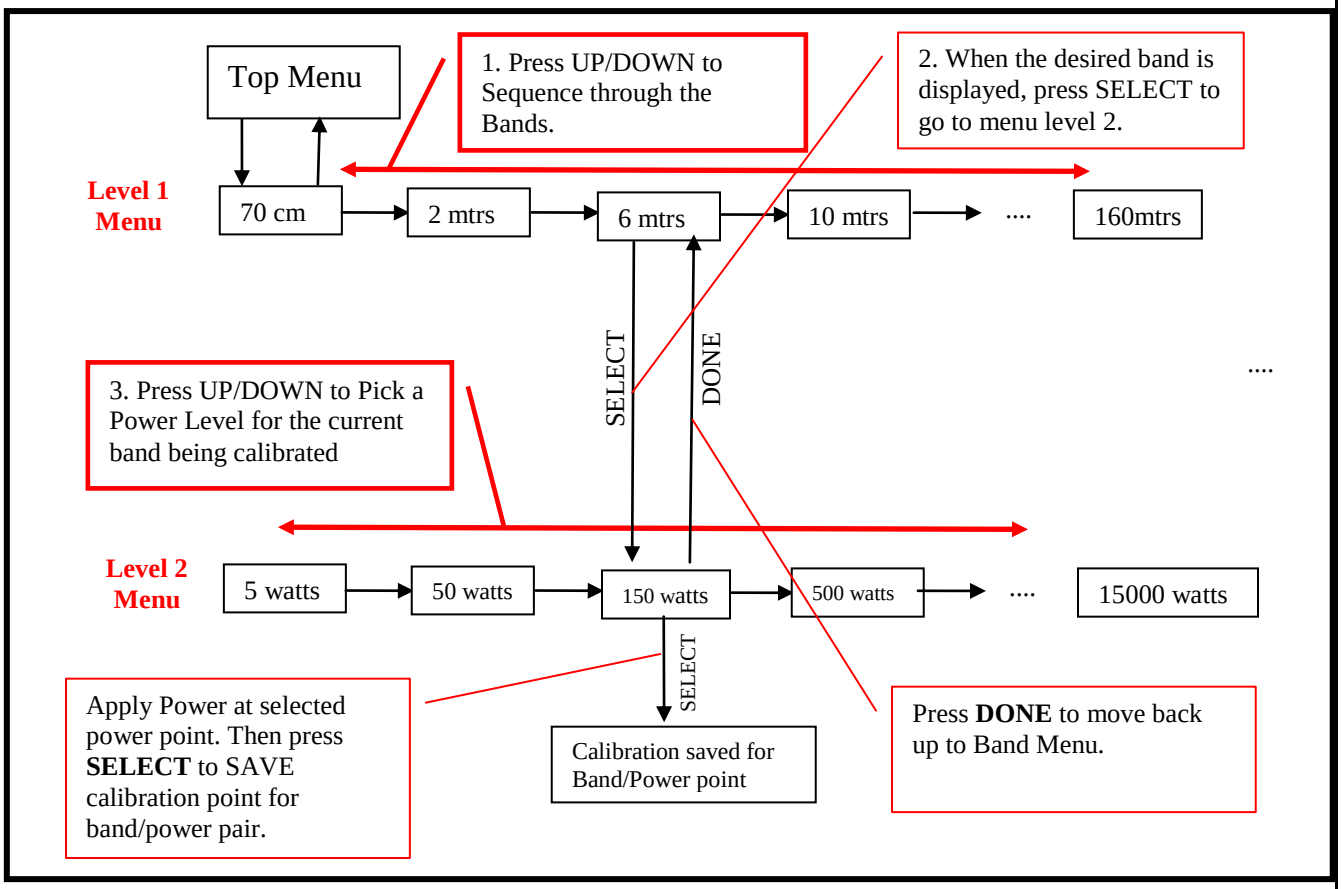
As discussed earlier, from the set of nine possible power points per band, only those power points that were calibrated at the reference band will be available for selection when you perform frequency compensation. Therefore, if you plan to perform band calibration, make sure that you include one or more of the power levels in **Table 15** when performing the Reference Band calibration.

Menu Nesting: Band calibration will be easier to use if you understand how the menus work for this function. Since multiple power points for multiple bands are involved in band calibration, the band calibration procedure makes use of nested menus.

The top level menu (referred to as level 1) is used to sequence through the 12 possible bands. Once you have selected the desired band, pressing SELECT brings you to a ***level 2 menu, where you can select one of the nine power points for the selected band.*** You stay at level 2 until you are finished calibrating all desired power points ***for that band*** (you can calibrate as few as one power point). You then exit the level 2 (power) menu and return to the level 1 (band) menu by pressing the **DONE** menu button.

When you are in the level 1 (band) menu, if do not wish to calibrate any additional bands, press **DONE** to exit the band menu. You are now at the top menu level, and are given the choice to save your settings, or to exit without saving them. ***To summarize, press DONE to exit to the next higher menu level. The following diagram illustrates this nested menu structure.***

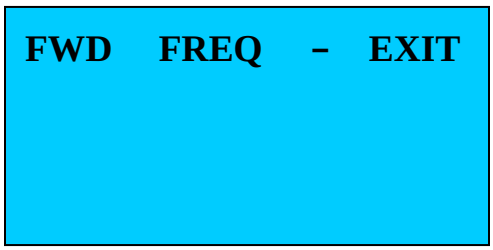
Figure 16 - Menus for Band Calibration



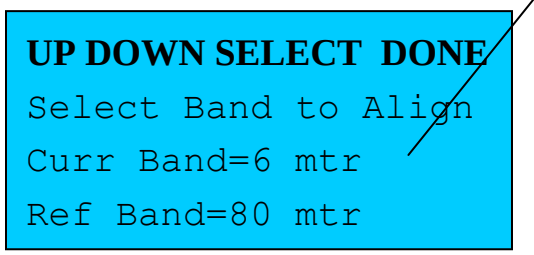
Steps:

The following steps assume that you are editing a previously calibrated coupler to add band calibration data. This operation can be performed while the original calibration is being done as well.

1. Bring up the Coupler Menu.
2. Press the **Set-Up** button to enter the setup screen.
3. ***Select the desired coupler with*** M1**.**
4. When prompted to erase previous settings, select NO.
5. In this example, the coupler is assumed to be already calibrated on the Reference Band. Therefore, you are then presented with a screen that gives you the option of editing either the **FWD** calibration (Reference band calibration), or frequency (band compensation). Since we are performing band calibration in this exercise, select **FREQ**.



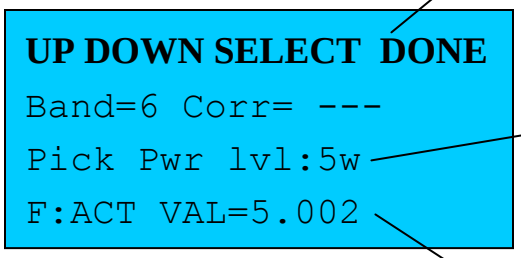
6. **Select a Band**: The meter is now at menu level 1 (the Band selection) menu. Push UP or DOWN to sequence through the 12 bands. When the band you want to calibrate is displayed, press SELECT.



This is the Level 1 Menu where you select the band to be calibrated. Push **UP/DOWN** to sequence through bands. Then press **SELECT**.

Line 4 displays the reference band. This is for information purposes only. The reference band was determined when you did the FWD Power (Reference) calibration for the coupler.

7. **Select a Power Point:** The meter is now at a level 2 (Power) menu. Press UP or DOWN to sequence through the available power calibration points. ***You will only be able to choose those power points that were calibrated when you performed the reference band calibration. Do not press SELECT until you are applying power at the correct level*** (described in next step).



This is the Level 2 Menu, in which you select the power point(s) to be calibrated. Line 2 shows the selected band and Correction Factor (--- if not yet determined)

Line 3 shows the nominal Power level that band is being calibrated at.

Line 4: To get the most accurate calibration, adjust the front panel pot so it agrees with the *actual* power being applied, as determined with an external reference meter. The FINE and COARSE options are available here as they were for the reference band calibration using the DOWN scroll button to toggle between the FINE and COARSE mode.

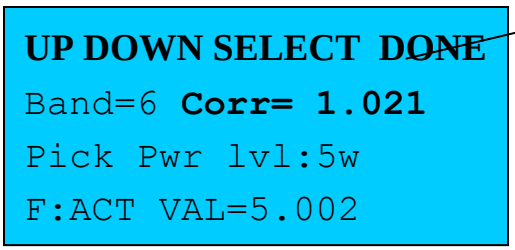
8. **Apply Power on Band being Calibrated:** Using a band compensated reference meter in tandem with the MB-1, apply power (5 watts in this example). As with the FWD calibration, you may not be able to apply power exactly that power level. Adjust the front panel pot so that the **ACT VAL** displayed on line 4 agrees with the actual power measured from your reference meter. ***To save the calibration point, press SELECT.*** This will read the ADC input, compare it to the corresponding calibration data for this power point on the reference band, and create a correction factor. The correction factor should be number fairly close to 1 for most couplers. If you see a much higher or lower number displayed on line 2 of the LCD, there was probably an error in your procedure. You can repeat the step simply by reapplying power, and pressing SELECT again. Once you are satisfied with the result, you have one of two options:

   - Stay at the level 2 menu so that you can calibrate another power level. In this case, press UP/DOWN to select a different power point on the same band (go to step 7).

     Note – to select another power level on this band, you must use the UP/DOWN buttons to select that power level. The power level does not automatically increment to the next available power level as it does during the FWD calibration of the Reference Band.

- Or press DONE. This will bring you back to the level 1 (Band) menu.

  If you wish to calibrate another band, press UP/DOWN to select the next desired band (go to step 6). If you do not wish to align another band, ***press DONE again***. This will bring you to the calibration exit point where you will be given the choice to save the calibration settings to EEProm, or to EXIT.



Line 2: After calibrating each point, the current correction factor for that band/power point pair is displayed.

(--- is displayed if the correction factor has not yet been determined.)

9. **Viewing the Correction Factors:** After completing band calibration, you can view the coupler settings by pressing the **DISP** button when the Coupler menu is active on line 4. This will display all relevant information for the currently selected coupler, including the newly calculated band correction values.

5.9 Coupler Calibration Error Messages

During coupler calibration, the software performs basic sanity checks on the calibration data and issues an error message when it detects a violation. ***For example, the coupler DC input signal at a 5 watt calibration point is expected to be higher than the coupler DC input signal for lower power levels***, and lower than the input signal for higher power levels.

When the software detects a violation of the above rule, an error message is displayed on the LCD. You should correct the source of the problem (e.g., make sure you are applying power at the correct level, and have the RCA cables connected to the correct coupler jacks on the rear panel of MB-1). Hit any one of the four menu buttons to clear the error message and continue with the calibration.

If the error is caused by a faulty calibration at a higher or lower power level, you can select the faulty calibration point (by pressing the NXT or PREV menu button), and delete this point using the DEL menu button. Then go back to the power level where the error occurred (using the NXT or PREV buttons), and continue. If this does not correct the problem, it is best to ERASE the settings for the entire coupler and repeat the calibration.

Possible Error Messages that can be issued during Coupler Calibration:

1. **THIS COUPLER TYPE**
   CAN NOT BE EDITED,

ONLY DELETED

A single point ***Quick Setup*** coupler cannot be edited since there are no variable parameters to calibrate. You will get this error message if you have assigned a Quick Setup coupler to a coupler port, and later try to perform an edit function on that coupler port. If you wish to assign a different type of coupler to this port, DELETE (erase) the entire coupler table first at the beginning of the calibration sequence when you are prompted to erase the existing settings.

2. **NO INPUT, VAL IGNORED** – You attempted to save a calibration point, but no signal was detected at the coupler port. (If this is happening only at low power levels, your coupler may lack adequate low power sensitivity. Select a higher power calibration point to start your calibration (e.g., .5 watts vs. .05 watts)).

3. **INVAL CAL AT THIS PT**
   N1 LOWER than N2 watts
   HIT ANY MENU BUTTON

   You attempted to save a calibration point, but the input signal at the N1 calibration point is lower than a previously calibrated point at a lower power level (at N2 watts).

4. **INVAL CAL AT THIS PT**
   N1 HIGHER than N2 watts
   HIT ANY MENU BUTTON

   You attempted to save a calibration point, but the input signal at the N1 calibration point is higher than a previously calibrated point at a higher power level (at N2 watts).

5. **INVAL CAL AT THIS PT**
   HIT ANY MENU BUTTON

   This message can occur during band calibration if the input signals for the nine (maximum) band calibration power points are not monotonically increasing as a function of the nominal calibration power level (for example, if the adc value measured for the 50 watt calibration point on the band being calibrated is lower than the adc value measured for the 5 watt calibration point on the band being calibrated).

6. **BND COR NOT POSSIBLE**
   NO REF BAND PWR PTS
   HIT ANY MENU BUTTON

   You attempted to enter the band calibration setup, but no calibration was performed on the reference band ***on any of the nine available band calibration power levels used for band correction (*****Table 15*****).*** Therefore, band calibration is not possible. If desired, you can edit the FWD (Reference Band) calibration and add calibration points at one or more of the required nine band calibration power levels.

7. **CORR FACT OUT OF RNG**
   HIT ANY MENU BUTTON

   The band correction factors should normally be fairly close to 1.0. Values of .8 – 1.2 are reasonable, but factors much outside of that range should be suspect. If you see factors outside of that range, unless you have reasons to believe they are legitimate for the coupler you are using, you should go back and repeat the band calibration for the suspect points.

   The software prevents you from saving calibration factors that vary significantly for 1.0. Calibration factors less than 0.5 or larger that 1.99 will cause this error to be declared, and the calibration data ***will not be saved for that point***. To correct this problem, simply press the menu button to repeat the calibration at the current band/power level point.

8. **"INVALID OPERATION" or "INVALID BUTTON" while in Reflected Channel Calibration Mode**

   While in the Reflected Channel calibration mode (which is used during adjustment of the side panel reflected channel trim pot), most buttons and operations are locked out until you terminate the Reflected Channel calibration mode with another press of M2. An attempt to select any other buttons will result in an "Illegal Button" or "Invalid Operation" error message respectively.

   You will also receive an "Invalid Operation" message if you try to enter the Reflected Channel calibration mode (long push on (M2) when it is not valid to do so. Examples of when it is not valid to enter this mode are when the current coupler is an ammeter or Generic Application, or when the Demo mode is on.

9. **"INVALID OPERATION" or "INVALID BUTTON" while in FWD PWR TRIM Mode**

   If you enter the FWD TRIM mode from the Coupler menu, most buttons and operations are locked out until you terminate the TRIM mode. You must terminate the TRIM mode either using M1 to save the TRIM value, or M2 to restore the TRIM value to its default value of 1.0.

10. **"INSUFF CALIB POINTS"**

    You must enter and save at least one calibration point before attempting to save the calibration table to EEPROM. Furthermore, ***for a Generic Meter Application, a single calibration point at 0 is not sufficient.*** If you have a Generic Meter Application with a calibration point at 0, you must have at least one additional calibration point in addition to the 0 calibration point.

5.10 Special Notes on Coupler Calibration

5.10.1 Notes on Band Calibration

As previously discussed, only those power levels that have been calibrated on the Reference Band are available for band calibration on each of the non-reference bands. After band calibration, if a calibration point is deleted from the Reference Band, if a corresponding calibration point exists on a non-reference band, that calibration point will be deleted as well when the updated data is saved to EEProm.

The TRIM function is not valid for Virtual Couplers. An attempt to use the trim function with a Virtual Coupler will results in an "Invalid Operation" error message.

5.10.2 Saturation Issues due to Band Sensitivity

As discussed above, to avoid saturation of the front end multiplexer/amplifier, you should adjust the side panel pot with Full Scale power applied to achieve a value of approximately 30,000 as displayed on the LCD. This provides a reasonable margin from the max value of 32736 supported by the amplifier/ADC chain. However, if you plan to perform band calibration, and if the bands you are calibrating have a somewhat higher sensitivity (generate a larger DC voltage for a given power level than the reference band), you may wish to use a somewhat smaller value than 30,000 to prevent possible saturation on the more sensitive bands. For most couplers, the difference in sensitivity between bands is small. If you set the reference band to the most sensitive band (usually the low bands such as 80 meters), this will not be an issue (the correction factors will be > 1 in these cases, therefore requiring a smaller DC voltage on the no reference bands to achieve a full scale reading). However, this issue is something you should be aware of.

6 Side Panel Coupler Pot Adjustments Using a Measurement Reference Meter or Multimeter

There are eight coupler trim pots located on the right side of the meter (one pot for the FWD port adjustment and one pot for the REFL port adjustment of each of the four couplers).

This section discusses how to use a reference meter or multimeter to adjust the coupler side panel pots. If you are doing a Multi-point Custom Coupler Calibration, the side panel pot adjustment will be done as part of the coupler calibration procedure. Therefore, this procedure applies only to the preloaded MB-HF1 factory coupler table. Since this coupler type already has a pre-set calibration table, they require only an adjustment of the FWD and REFL sensitivity pots at a single power level.

You can use one of two procedures. The first procedure uses a reference power meter in series with MB-HF1 coupler. This method can also be used for any other type of power coupler.

The second procedure uses a multimeter to adjust the side panel pots, and applies only to the included MB-HF1 coupler (whose power-to-voltage benchmark settings are printed on the label of the MB-HF1 coupler case).

6.1 Calibration using a Reference Power Meter:

1. Determine the coupler number that you are going to use (1 – 4). Plug a dual RCA cable between the coupler and the selected coupler port in the rear of the meter matching the red/white colors of the RCA plugs. Connect devices in the following order:

   Transmitter --> MB-HF1 Coupler --> Reference Meter --> 50 ohm Dummy Load

2. This step describes how to adjust the FWD coupler trim pot.
   Select the coupler number (1 – 4) using the **COUP** menu and M1. ***You will not enter the SETUP screens, since it is assumed you are using a preloaded calibration table.***

   Apply power from your transmitter. You should choose a power level that is reasonably "in-range" of the coupler's full scale value. For the four factory preloaded tables that are automatically loaded into MB-1 for coupler ports 1 - 4, the following levels are suggested, but are not critical:

   Coupler 1 – 100 watts
   Coupler 2 – 10 watts
   Coupler 3 – 50 watts
   Coupler 4 – 200 watts

   Adjust the FWD trim pot (right side of the meter) corresponding to the coupler number you are using. Adjust that pot so that the reading on MB1 agrees with the reference meter. ***Remove transmit power.***

3. This step describes how to adjust the REFL coupler trim pot.
   When adjusting the REFL coupler trim pot, you must first place MB-1 in the

Reflected Channel Calibration" mode with a long press of the M2 button. The Yellow LED on M2 will flash to confirm that you that you are in this mode. Note – when in this mode, disregard all readings except the REFL power reading.

Remove transmit power.

Swap the PL-259 connectors on the coupler. ***This will cause the FWD power applied by the transmitter to be measured by the coupler's REFL port. Leave the reference meter in its original configuration.*** Apply a power comparable to the power level you used for the FWD port adjustment. Adjust the REFL coupler trim pot corresponding to the coupler number you are using until the Reflected Power that is displayed on MB-1 agrees with the reference meter.

To achieve maximum accuracy during this step, the filters are set to a very long time constant while in the Reflected Channel calibration mode, and you will see that the reflected power numeric value response is somewhat sluggish with respect to adjustments made to the reflected channel trim pot. To ensure that the trim pot is adjusted correctly while in the Reflected Channel Calibration mode, the Constant signal indicator feature is automatically activated. This will cause the green LED on and M1 to light once the filters have reached their final value. Therefore, after adjusting the Reflected Channel pot, wait for the Constant Signal indicator (green LED on M1 to light). If the reflected power numeric reading does not match the intended setting, continue to adjust the pot, checking the displayed value each time after the Constant Signal indicator illuminates.

Remove transmit power.

After you are done adjusting the REFL coupler trim pot, turn off the Reflected Channel Calibration" mode off with a long press of the M2 button. The yellow LED on M2 will stop flashing.

4. Reconnect the FWD and REFL RCA cables back to their normal positions.

6.2 MB-HF1 Coupler Calibration using a DC Multimeter

This procedure applies only to the included MB-HF1 coupler.

For this procedure, you will have to read FWD (TUNE) power and REFL power on one of the MB-1 display devices set to display "TUNE" (instantaneous) power.

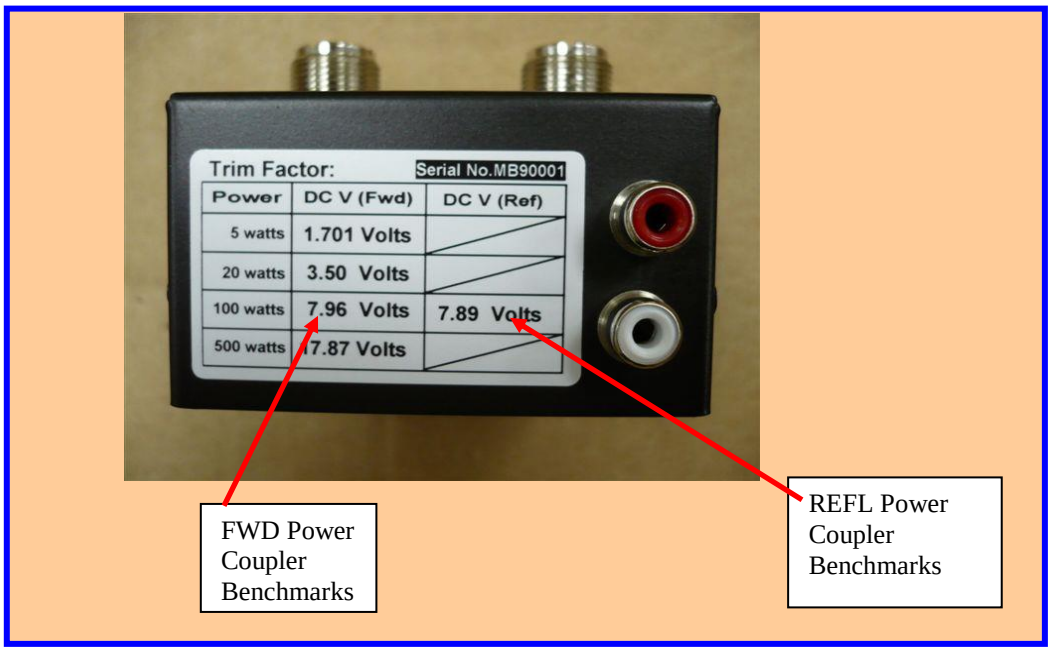
1. Determine the coupler number that you are going to use (1 – 4). If you are using the factory defaults and setting up the MB-HF1 coupler, you will be using Coupler port 1. Plug a dual RCA cable between the coupler and the selected coupler port on the rear of the meter matching the red/white RCA plugs. Connect devices in the following order:

   Transmitter --> MB-1 Coupler --> 50 ohm Dummy Load

Use an RCA Y connector ***at the meter head end*** so that you can feed the FWD port DC signal from the ***coupler into both the MB-1 control head FWD port RCA jack, and a high impedance multimeter set to read DC voltage.***

2. Bring up the **COUP** menu on line 4 of the LCD, and select the desired coupler number by pressing M1. Apply power and adjust the transmitter until the multimeter reads the DC voltage of one of the FWD power benchmark calibration points on the coupler. For example: 100 **watts = 7.96 volts**

Figure 17 - Coupler DC Voltage Benchmarks



3. At this point, you know the value of the applied FWD power (100 watts in the above example, since that is the benchmark value). Adjust the FWD port side panel pot until MB-1 (in TUNE mode) reads that power. ***Remove transmit power***.

4. This step describes how to adjust the REFL coupler trim pot.
When adjusting the REFL coupler trim pot, you must first place MB-1 in the Reflected Channel Calibration" mode with a long press of the M2 button. The Yellow LED on M2 will flash to confirm that you that you are in this mode. Note – when in this mode, disregard all measurements except the REFL power measurement.

Swap the PL-259 connectors on the coupler. ***This will cause the FWD power applied by the transmitter to be measured by the coupler's REFL port.*** Remove the RCA Y connector and connect it to the REFL port so that the REFL port signal from the coupler is feeding both the MB-1 REFL port RCA jack and the multimeter through the Y connector. Apply power and adjust the transmitter until the multimeter reads the DC voltage of the REFL power benchmark calibration points on the coupler. For example: **100 watts = 7.89 volts**

5. At this point, you know the value of the applied REFL power (100 watts in the above example, since this is the benchmark value). Adjust the REFL port side panel trim pot until MB-1 reads a REFL power of 100 watts.

   To achieve maximum accuracy during this step, the filters are set to a very long time constant while in the Reflected Channel calibration mode, and you will see that the reflected power numeric value response is somewhat sluggish with respect to adjustments made to the reflected channel trim pot. To ensure that the trim pot is adjusted correctly while in the Reflected Channel Calibration mode, the Constant signal indicator feature is automatically activated. This will cause the green LED on and M1 to light once the filters have reached their final value. Therefore, after adjusting the Reflected Channel pot, wait for the Constant Signal indicator (green LED on M1 to light. If the reflected power numeric reading does not match the intended setting, continue to adjust the pot, checking the displayed value each time after the Constant Signal indicator illuminates.

   Remove transmit power.

6. **After you are done adjusting the REFL coupler trim pot, make sure to turn the Reflected Channel Calibration" mode off with a long press of the M2 button. The yellow LED on M2 will stop flashing.**

7. Disconnect the Y connector and reconnect the FWD and REFL RCA cables back to their normal positions.

The coupler is now ready for use.

7 RF Ammeter Applications

7.1 Overview

Section 5 described the coupler calibration process in detail. During coupler setup, you specify the coupler type you are calibrating as one of the following:

- Power Coupler
- RF Ammeter
- Generic Meter

Power Couplers assume a square law relationship between the voltage and the incident power. RF Ammeter couplers and Generic Meter Applications both assume a linear relationship between the parameter of interest and the DC voltage delivered to the coupler port. For both RF Ammeter and Generic meter applications, only the FWD port of the selected coupler port is used on the MB1 control head.

7.2 How many calibration points should you chose?

As with the RF Power coupler, if the RF ***current*** coupler was ideal, you would need a single calibration point. But like power couplers, current couplers are not ideal. Therefore, you can achieve better accuracy by calibrating an RF current coupler at multiple points.

Assume that you want to calibrate an RF Ammeter and your station is capable of generating a maximum of ***x watts*** into a dummy load. The corresponding RF current is:

$\text{RF-Curr}_{max} = \sqrt{x/50}$

For a power of 1000 watts,

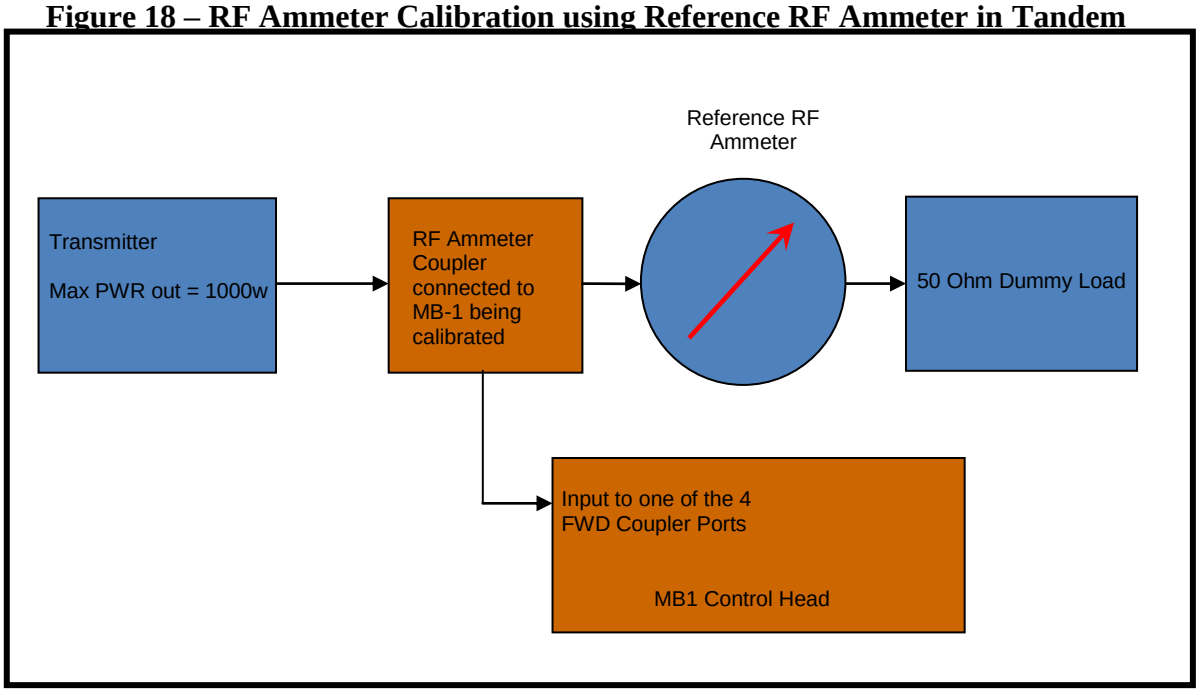
$\text{RF-Curr}_{max} = \sqrt{x/50}$ = 4.47 Amps RMS

In this case, a reasonable choice would be to set the full scale current during RF Ammeter calibration to 5 or 6 amps, and then calibrate the RF ammeter coupler at 0.1, 0.5, 1, 2, 3, and 4 amps. These six points should provide good tracking over the entire current range. (It should be noted that RF currents whose values are less than the minimum calibration point, or RF currents whose values are higher than the maximum calibration point value ***will still be processed and displayed by MB1***. This is accomplished by using the calibration data for the lowest or highest available data point respectively.)

7.3 Calibration Method

There are two ways to use reference meters in tandem with your RF Ammeter coupler to perform the calibration. The first is to insert a reference RF ammeter in series with the ammeter coupler you are calibrating. This is shown below:

Figure 18 – RF Ammeter Calibration using Reference RF Ammeter in Tandem



The second procedure uses an accurate RF power meter in tandem with the RF ammeter coupler you are calibrating. You then calibrate the RF Ammeter at current points ***corresponding to power levels being measured*** by the reference power meter. Since "Reference" RF power meters are more readily available than "reference" RF Ammeters, most users will probably use this approach.

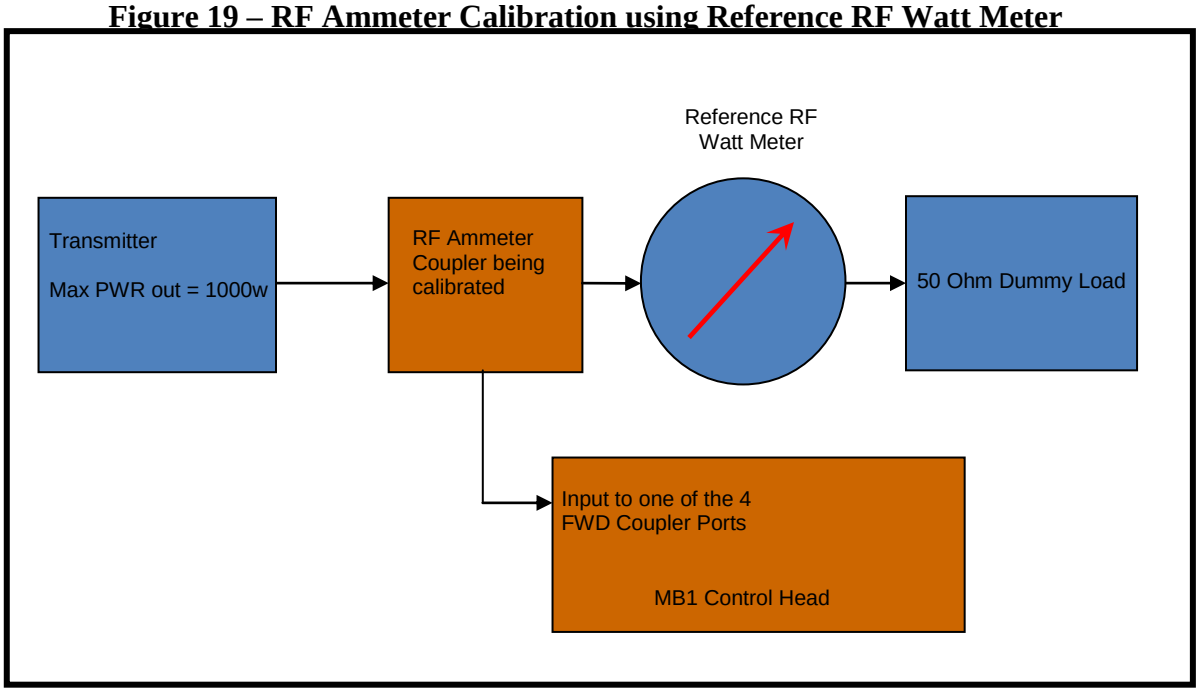
In fact, you can even use the MB-HF1 coupler as your reference power coupler if you are willing to set up one RF current point at a time by first adjusting the power to a reference point as read by the MB-HF1 coupler. You would then have to select the RF current coupler number and place it in SETUP mode, calibrating at a single point. You would have to repeat these steps, using the EDIT capability of the Coupler Setup screens to add one RF current point at a time – a bit inconvenient, but doable).

To calibrate at the six current points suggested in the above example, the corresponding power levels into a 50 watt dummy load are:

Table 16 – Current/Power Relationship into a 50 ohm resistive Load

RF Current Calibration Point	Corresponding Power
0.1	0.5 watts
0.5	12.5 watts
1	50 watts
2	200 watts
3	450 watts
4	800 watts

Figure 19 – RF Ammeter Calibration using Reference RF Watt Meter



8 Panel Meter Calibration

8.1 Meter Scale Types

You can add a wide variety of analog meters to MB-1 including meter movements from unused Amateur gear. This section describes the type of meters and meter scales you can use with MB-1.

You can use any of the following types of meters with MB-1:

1. Linear Scale Meter Movements

2. Non-linear Scale (single needle) Meter Movements, even if they have two scales, such as a power scale and SWR scale, as typically found in Amateur wattmeters.

3. Crossneedle Meter Movements (linear or non-linear)

Below, we show some Power/SWR meter scales that can be used with MB-1.

Example 1:
The first example, Figure 20, has both ***a linear Power Scale and a linear SWR Scale***. Since both of these scales are linear, ***a meter with this scale arrangement can be calibrated using the Linear Scale calibration procedure described below in section 8.3.*** Such scale faces are rare, but we have designed some of these scales and made them available on www.meterbuilder.com.

Example 2:
The second example, Figure 21, has a ***linear Power Scale and a nonlinear SWR Scale***. These, too, are somewhat rare. We have also made some of these scale types available on www.meterbuilder.com.

Example 3:
The third example, Figure 22, has a ***nonlinear Power Scale and a nonlinear SWR Scale***. These are probably the most common types of scales used in Amateur Radio equipment. The nonlinearity usually exists in existing Amateur Radio gear since it is far easier for a meter manufacturer to make the scale match the readings compared to designing a circuit, especially an analog circuit that would give the correct results on a linear scale. We have also made some of these scale types available on www.meterbuilder.com.

Figure 20 – Example 1 -Linear Power Scales and Linear SWR Scale

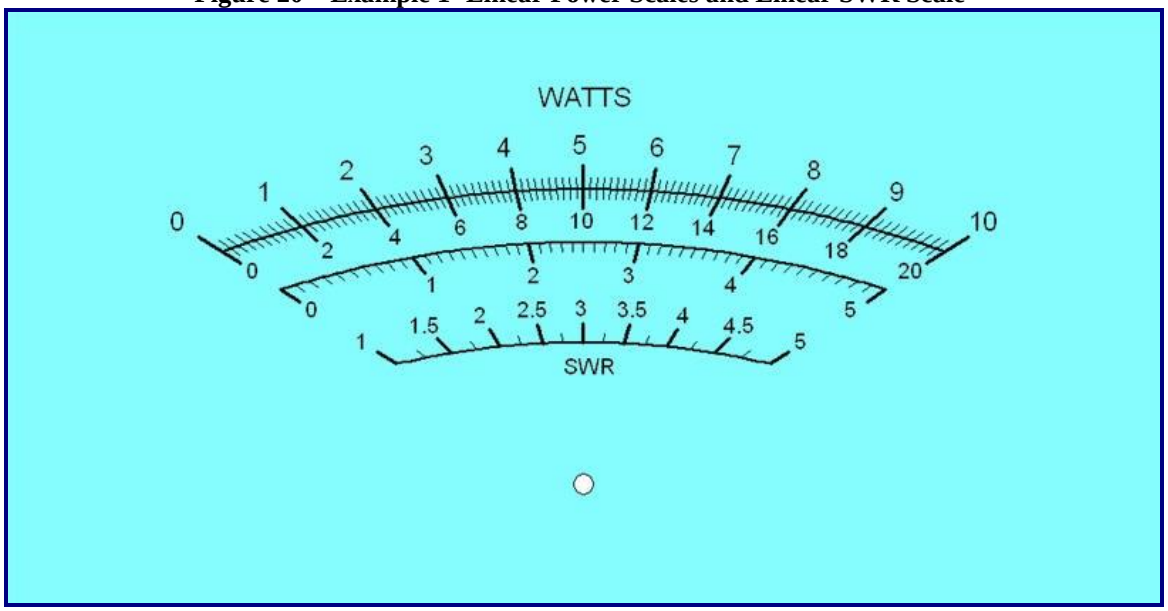


Figure 21 – Example 2 -Linear Power Scales and Nonlinear SWR Scale

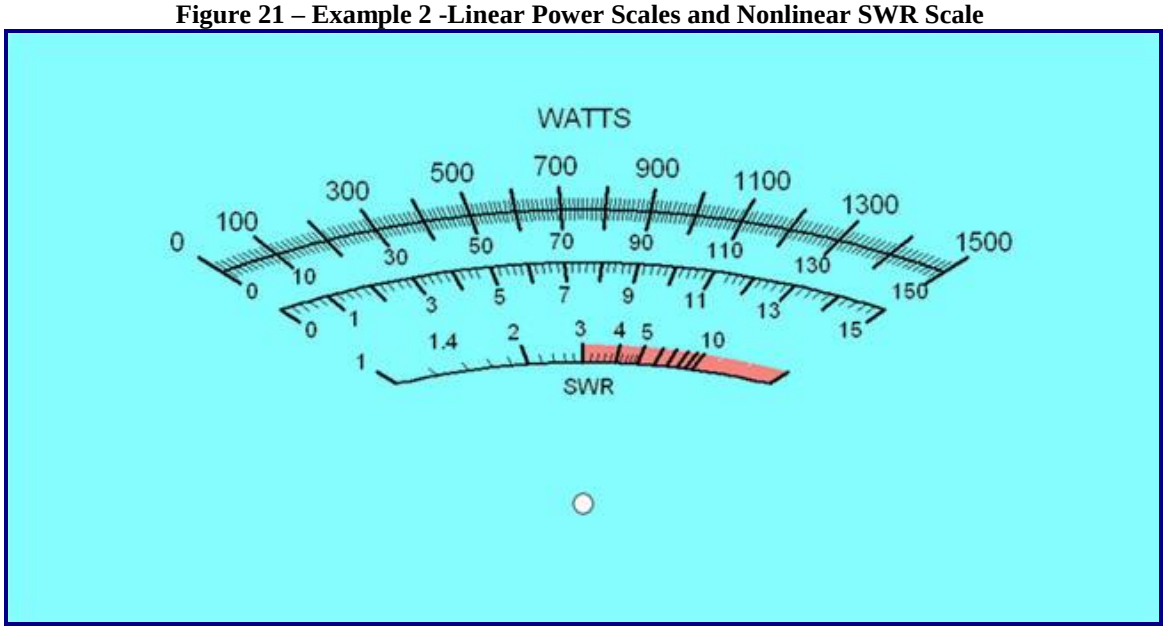
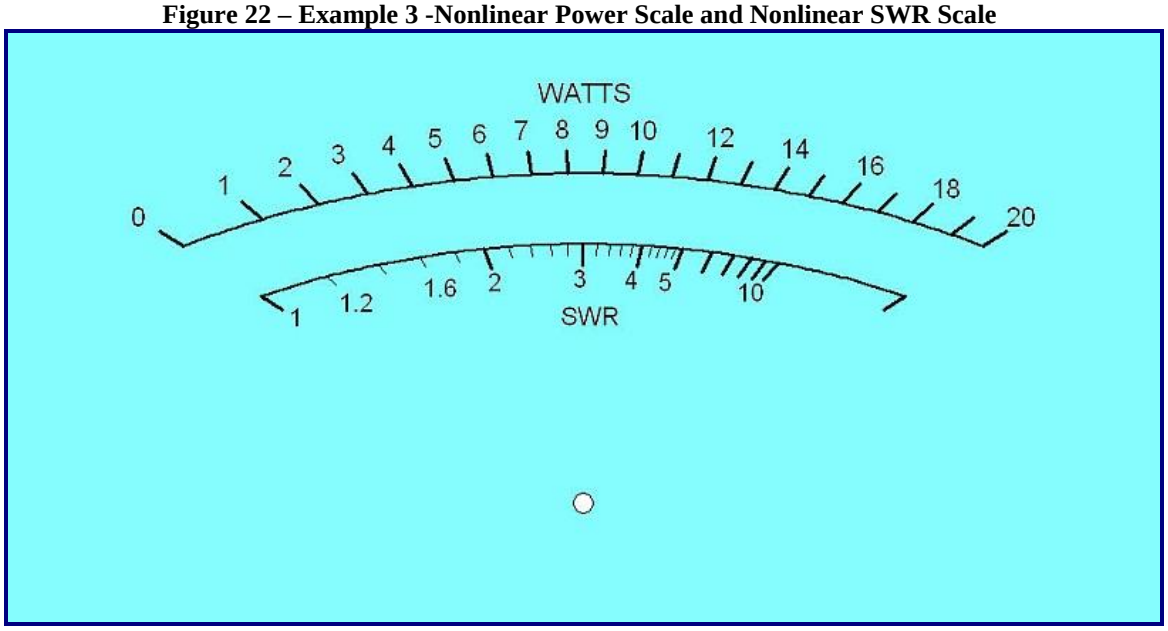


Figure 22 – Example 3 -Nonlinear Power Scale and Nonlinear SWR Scale



MeterBuilder can accommodate any of the above scale types. Actually, you may find the scale type in example 2 to be the most useful. It provides a linear power scale, which most users find more desirable than a nonlinear power scale. And it provides a nonlinear SWR scale with an expanded scale on the low end of the SWR range, which gives you more resolution where you want it.

Whether you are buying a DC meter on eBay (most of which are linear scales), whether you are reusing a meter with a power scale from an unused piece of Amateur Radio equipment, or if you decide to apply one of the meter faces on the MeterBuilder web site to a meter or even design your own meter face, you will be able to calibrate the meter it to work with MB-1.

When calibrating a panel meter using MB-1, keep this simple rule in mind. ***If the meter face has one or more nonlinear scales, that Panel Meter must be calibrated as a nonlinear meter***. This does not pose a problem if the meter face also has a linear scale, since a linear scale can always be treated as a special case of a nonlinear scale. Therefore, only the first example above should be calibrated as a Linear Scale meter when using the setup menus. ***The last two examples must be calibrated as nonlinear***. When you specify a meter type as nonlinear during the calibration, you have the ability to ***calibrate both the PWR and SWR scales independently of each other***. The calibration data for each scale is saved in separate tables in EEProm.

One other thing to keep in mind is the linearity of the meter movement itself. Regardless of the scales on the meter face, most DC meter movements are linear (i.e., 25% of the FS current drives the needle 25% up scale, 50% of the FS current drives the needle upscale 50%, etc.). If you are using a meter that has a nonlinear meter movement, regardless of types of scales on the meter face, you must calibrate that meter as a nonlinear meter. (However, nonlinear meter movements with linear scales are rare).

8.2 Meter Movement Sensitivity

To use a meter movement with MB-1, it must have a full scale sensitivity of 1 mA or less. Meter movements of 30 uA, 50 uA, 100 uA, 200 uA, 500 uA, and 1 mA are quite common and should be easy to find. In fact, the meter movements used in most amateur power meters and antenna tuners meet these requirements. To determine the ***approximate*** full scale sensitivity of a meter movement that you may be considering for use with MB-1, two of the rear panel RCA jacks provide an ***approximate current source*** of 50 uA and 200 uA that you can connect directly across a meter movement to determine its approximate full scale sensitivity. The current source is just a voltage in series with a resistor, but the current source approximation is valid as long as the meter movement resistance is much lower than the fixed series resistor in MB-1's current source (which is usually the case). You can also use the FR-POT jack with the front panel pot adjusted to its maximum CW travel to approximate a 1 mA source (the front panel pot wiper is connected to rear panel RCA jacks through a 5.1K resistor).

8.3 Linear Scale Meter Calibration

This section describes the steps to calibrate a linear scale panel meter – one that consists entirely of linear scales. The steps are similar for the other scale types. Differences in the steps for calibrating Non-linear and Crossneedle meters will be discussed later.

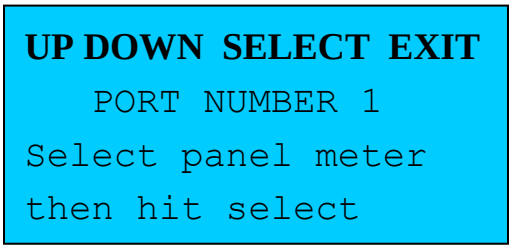
The steps to calibrate a panel meter are given below:

1. Adjust the corresponding panel meter pot (2 pots must be adjusted for crossneedle meters) to approximately 20% of their maximum travel). This is simply a precaution to prevent possible meter movement damage during calibration.

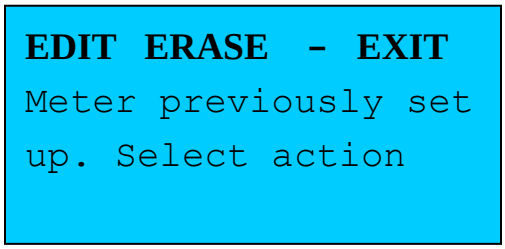
2. Bring up the Panel Meter Menu (**PanMtr**) on line 4.

3. Press the **Set-Up** button.

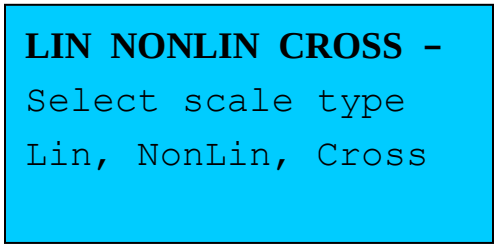
4. **Select the Panel Meter Port you wish to calibrate:** Ports 1 and 2 are connected to internal crossneedle meter FWD and REFL needles***. Calibration on a crossneedle meter needs to be performed on an odd numbered Panel Meter port (1, 3 or 5). Furthermore, each crossneedle meter uses 2Panel Meter ports (1-2, 3-4, and 5-6).***



5. **Erase previous Settings:** If the selected Panel Meter port was previously calibrated (contains settings), you are given the option to erase the settings or to edit hem. If there are no previous settings, push EDIT (M1) to proceed with a new calibration. If there are previous settings that you wish to discard, press ERASE (M2).

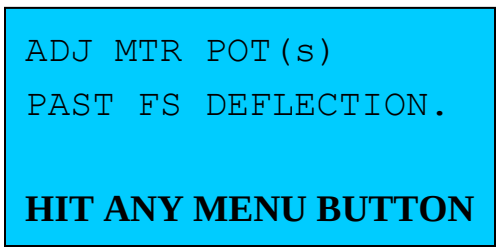


6. **Select Scale Type (M1 – M3)** – based on whether the meter movement has a linear scale (M1), a non-linear scale (M2), or is a crossneedle meter (M3).

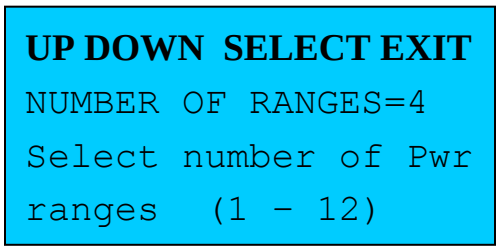


7. **Side Panel Pot Adjustments:** At this point, the software drives the panel meter ports with the maximum output that can be generated by the D-to-A converter(s). Adjust the pot on the left side panel (2 pots require adjustment for crossneedle meters) to obtain maximum needle deflection. Adjust the needle(s) ***somewhat past*** full scale without overdoing it to provide some margin for calibration. In most cases, you can safely bring the needle to its maximum travel of the mechanical stop. This extra deflection will also allow you to use the ***Soft Overrange*** feature if desired (which drives the meter needle slightly past the full scale reading in the presence of an overrange condition so that the overrange condition can be readily observed by the user).

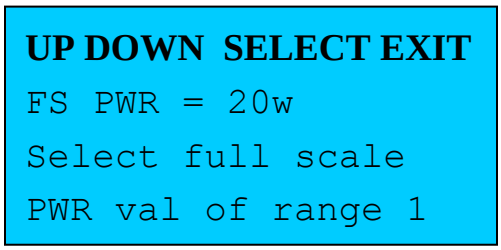
   Hit any menu button (M1 – M4) to remove the D-to-A drive and return the needles to their rest positions.



8. **Select Number of Power Ranges:** (1 – 12 for a linear scale meter movement)

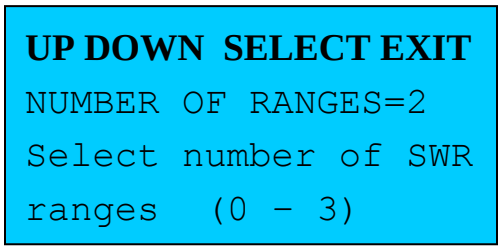


9. **Select Full Scale Value of First Range.** Repeat this step for each of the remaining three power ranges (Only 4 power ranges of the possible 12 are used in this example, as selected above).

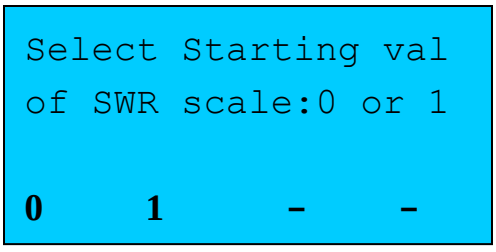


...

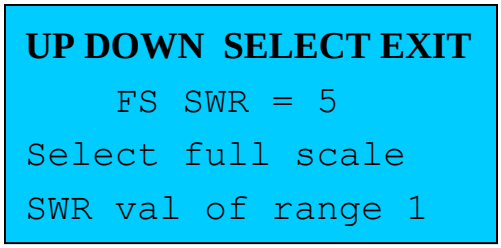
10. **Select Number of SWR Ranges:** (0 -3)



11. **Select the Starting Value of the SWR Scales –** Normally, SWR scales start at 1. ***But if you are using a meter that starts at 0, and you want to use the meter to display SWR readings, the software will adjust the meter output so that SWR values will be displayed properly.*** Enter 0 if the scale starts at 0. For a standard SWR scale (which starts at 1), enter 1. (Note that most linear meters that have a single linear scale start at 0).



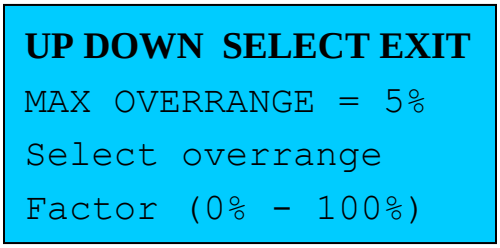
12. **Select Full Scale Value of the First SWR Range.** Repeat this step for the remaining SWR ranges (2 SWR ranges total are used in this example).



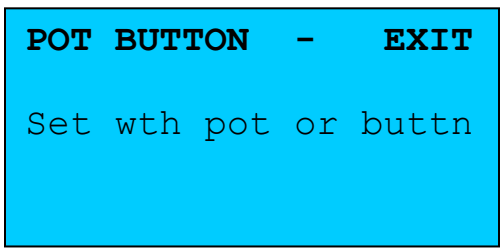
. . .

13. **Select the Soft Overrange Value –** This screen allows you to configure the panel meter so that an overrange condition will be observable by providing some degree of deflection ***past the full scale point*** without risking damage to the meter movement.

    The overrange value can be set in the range 0 – 100%. A 5% - 10% "Max Overrange" setting will give you maximum needle deflection of approximately 5 – 10% ***past full scale***, which is easily recognizable, but will not damage the meter movement. If you wish to disable the soft overrange feature altogether, set this value to 0 (no overrange deflection).

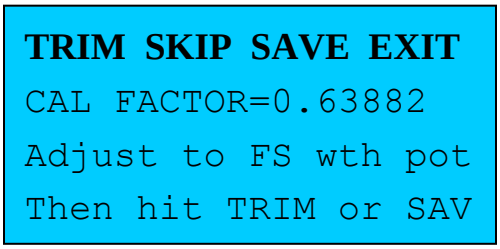


14. Select either ***the front panel pot*** (M1) or (menu UP/DWN) buttons (M2) to perform the actual calibration. This selection determines which of two procedures (front panel pot adjustment, or pressing the UP/DOWN menu selection buttons (M1 and M2)), will be used to advance the meter needle to each calibration point on the meter face.

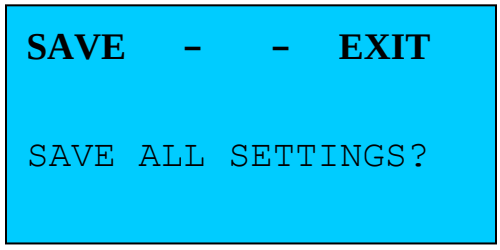


15. **Perform the Actual Calibration - Adjust Meter to Full Scale**.
Based on which method you selected, use either the front panel pot or UP/DWN menu buttons, to move the needle to its full scale position. ***For a linear meter movement, the full scale calibration point is the only point that requires calibration.*** The screen below is the one that is used when the front panel pot (vs. buttons) is being used for calibration.

After adjusting the needle to full scale with the front panel pot, press SAVE (M3) to save the setting, ***or press TRIM if you want to now use the UP/DOWN buttons to further refine the adjustment made by the pot before saving it.*** The screen below is the one you will see if you chose to ***not*** run this optional trim step. The Calibration factor shown on line 2 of the screen below is the value that the software will use to drive the meter to full scale. This value will be saved in the Panel Meter's EEProm calibration table.

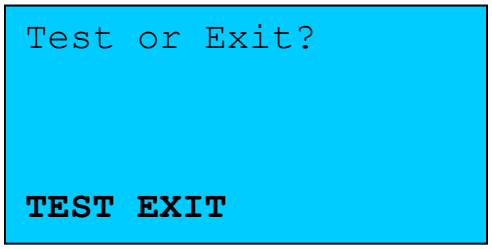


16. Save Settings



17. **TEST or EXIT**

At the end of the Panel Meter calibration sequence, you are given the choice to **TEST** or **EXIT**. Select TEST (M1) to run a quick test on the calibration you just performed, or EXIT (M2) to exit without running a test. The TEST function allows you to verify the calibration by driving the meter exactly to its full scale deflection. If your calibration is not accurate, you can use the EDIT function described below to correct the calibration without having to repeat the entire calibration procedure.



8.4 Nonlinear Scale Meter Calibration

For Nonlinear scale calibrations, the main difference from the linear scale alignment discussed above is that you will need to calibrate both the power scale and SWR scale of the nonlinear ***scale at multiple points*** instead of a single point as was done at the Full Scale point for a linear scale.

Another difference is in the number of scales, and the relationship between scales. MB-1 accommodates up to three power ranges and one SWR range when you specify a nonlinear scale during setup. ***Furthermore, each range has an implicit 10-to-1 relationship with the next lower range. For example, assume that you have a nonlinear scale with a full scale value of 20. For nonlinear scales, you would specify only the lowest power scale during calibration. In this case, if you specified the low power scale at 20 watts, your three scales would be 20, 200 (20 x 10), and 2000 (20 x 100). If you defined your low scale at 2, your three scales would be 2, 20, and 200. If you defined your low scale at 200, your three scales would be 200, 2000, and 20,000.***

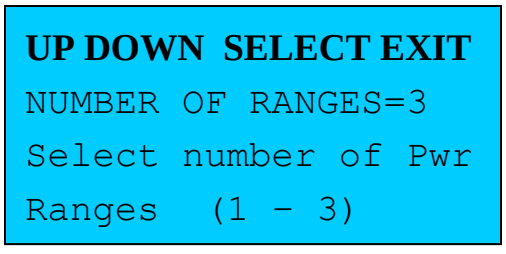
How many points do you need for a nonlinear scale? MB-1 supports up to 50 points ***for each*** of the two non-linear scales. However, 20 points will generally do a good job on most meters (typically, the bigger the meter and the more nonlinear the scale, the more points you will need for an accurate mapping).

You can select a different number of calibration points for the Power and SWR scales. Select the number of points for convenience. For example 20 points on a power scale that has a full scale range of 20 will give you exactly 1.0 watt increments for each point, which makes it easy to "dial in" the needle during calibration with the pot or UP/DOWN buttons. If you have an SWR scale that ranges from 1 – 10, selecting 18 points simplifies things. Your calibration points will be at the following SWR values: SWR = 1.5, SWR = 2.0, **...** SWR = 10.0.

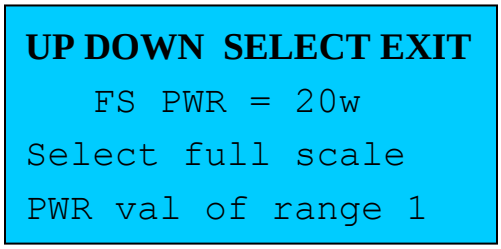
8.4.1 Screens Specific to Non-Linear Scale Meters

The following shows the main screens that are specific to non-linear scale calibration. As discussed earlier, many of the steps described above for Linear Scale calibration are applicable to nonlinear scale calibration as well.

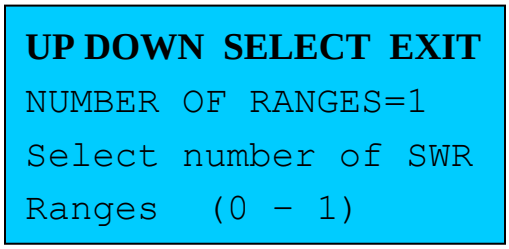
1. **Select Number of Power Ranges (a max of 3 for nonlinear scales)**



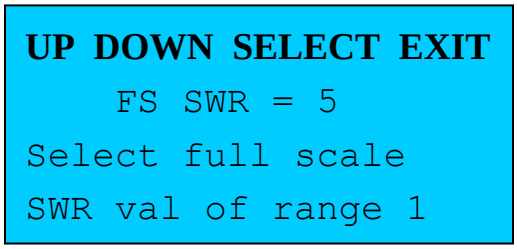
2. **Select Power Range 1** (Since 3 ranges were specified above, the other two power ranges are automatically set to x10 and x100 the value specified for range 1.



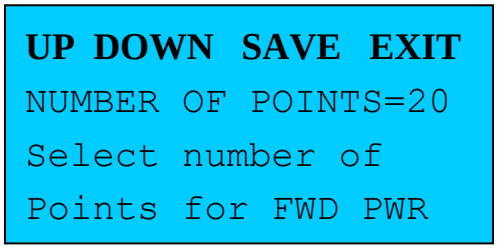
3. **Select Number of SWR Scales**



4. **Select SWR Range 1** (Select 0 if you are calibrating a panel meter for power measurements only).



5. **Select Number of Points for Power Scale**
On this screen, you enter the number of points you want to map the power scale with. Twenty points is usually sufficient to provide an accurate mapping. The maximum number of points is 50. ***For meter faces that contain a separate power and SWR scale (the normal case), you must specify the number of points for each of the two scales.*** They need not be the same.



6. **Select Number of Points for SWR Scale**

```
UP DOWN  SAVE  EXIT
NUMBER OF POINTS=18
Select number of
Points for SWR SCALE
```

7. **Calibration of Power Scale –** As before, you are given the choice to perform the calibration by adjusting the needle with either the front panel pot, or with the UP/DOWN buttons. Since we used the front panel pot in the linear scale example above, we have chosen the UP/DOWN buttons in this example.

   Using the pot or UP/DOWN buttons (M1 and (M2)***, advance the meter needle to the first calibration point on the meter face.*** Then press SAVE. ***Repeat this operation for each calibration point on the power scale*** (20 total points in this example). You will be prompted for each point on the LCD screen. The **PRV** button may be used to go back to a previous setting to redo its calibration if required. **SC1** below indicates that **scale 1** (the Power scale) is currently being calibrated.

```
UP DOWN  SAV/PRV EXIT
  DtoA Value =0
SC1 PT 002 Use UPDWN
to set mtr to 2.0
```

8. **Calibration of SWR Scale –** The process is then repeated for calibrating the SWR scale. **SC2** below indicates that **scale 2** (the SWR scale in this example) is currently being calibrated.

```
UP DOWN  SAV/PRV EXIT
    DtoA Value =0
SC2 PT 001 Use UPDWN
to set mtr to 1.50
```

8.5 Crossneedle Meter Calibration

Calibration of Crossneedle meters is similar to non-linear scale calibration described above. There is just one key difference:

- ***The number of scales for the FWD needle and REFL needle must be the same*** (typically you will choose 3 scales). The x10 and x100 rules that apply to non-linear scales apply to crossneedle meters as well. ***For example, if we set the range***

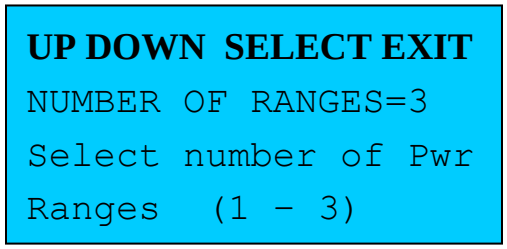
of the FWD low power scale to 20, and set the range of the REFL low power scale to 5, this will give us a meter that has three FWD full scale ranges of 20 watts, 200 watts, and 2000 watts, and three REFL full scale ranges of 5 watts, 50 watts, and 500 watts. (These are the default values that the MB-1 crossneedle meter is calibrated at.)

As with the Non-linear scale adjustment procedure described above, you can select a different number of calibration points for the FWD and REFL scales. As with the non-linear scales, select the number of points for the FWD and REFL scales for convenience (e.g., that line up with the tick marks on the meter face).

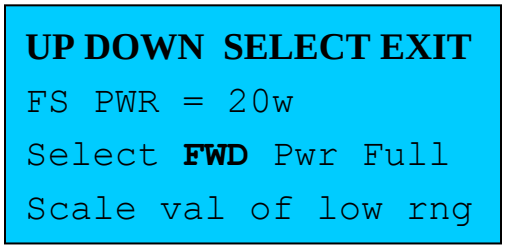
8.5.1 Screens Specific to Crossneedle Meters

The following shows the main screens that are specific to crossneedle meter calibration.

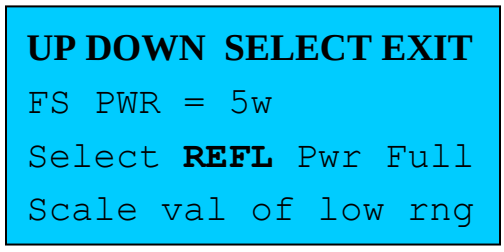
1. **Select Number of Power Scales**



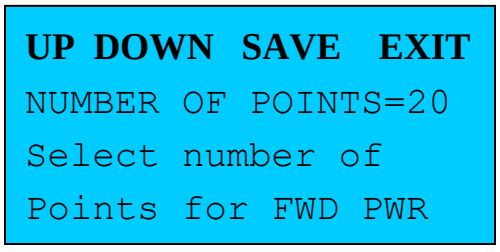
2. **Select FWD Power – Only the Low range is specified**



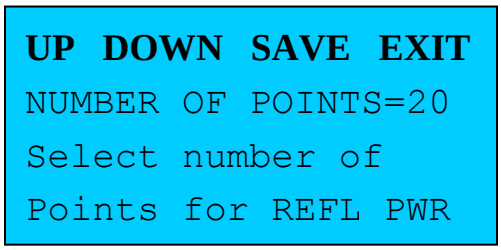
3. **Select REFL Power - Only the Low range is specified**



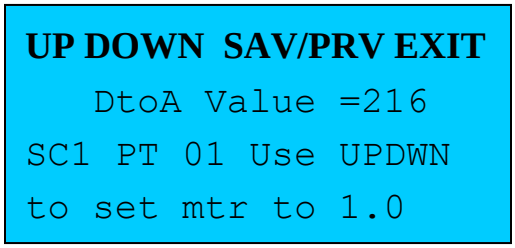
4. **Select Number of Points for FWD Power Scale**



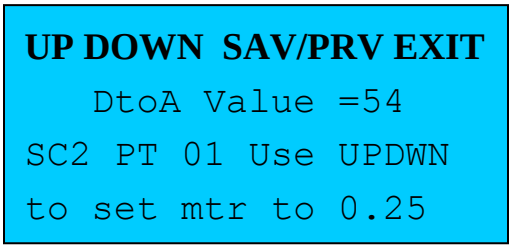
5. **Select Number of Points for REFL Power Scale**



6. **Calibration of FWD Power Scale –** Using the pot or UP/DOWN buttons, move the FWD meter needle to the first calibration point as prompted on the LCD. Then press SAVE) (M3) to save the calibration point. You need to repeat this for each point (20 points in this example). **SC1** below indicates that scale 1 (FWD power scale) is currently being calibrated. Since we have chosen 20 calibration points with a FWD full scale value of 20 in this example, the calibration points will be at 1 watt intervals (1.0, 2.0, 3.0, ... 20.0).



7. **Calibration REFL Power Scale –** Same as above but for reflected power scale. **SC2** below indicates that scale 2 (Reflected power scale) is currently being calibrated. Since we have chosen 20 calibration points with a REFL full scale value of 5 in this example, the calibration points will be at 0.25 watt intervals (0.25, 0.50, 0.75, ... 5.0).



Note: If you use the pot to adjust the settings instead of the UP/DOWN buttons, the D-to-A value shown on line 2 is not displayed. Instead, one of the following two messages is displayed on line 2 when using the front panel pot:

”* FWD PWR CALIB *“
or
”* REFL PWR CALIB *“

8.6 Calibration of the Built-in Crossneedle Meter - Detailed Steps

With the above background, we now present the ***complete procedure*** for calibrating the internal crossneedle meter that is provided with MB-1. Some of the steps discussed above in the general guidelines for calibrating Panel Meters are repeated here to make this section self contained.

Even though the internal meter supplied with MB-1 has linear power scales, all crossneedle meters are treated as non-linear scale meters (since most of them are). Additionally, the actual meter movement supplied with MB-1 has a slight bit of non-linearity. By calibrating both the forward and reflected needles ***at two points instead of one***, we will achieve good tracking.

For crossneedle meters, the maximum number of forward and reflected power scales you may configure in each direction is three. ***The full scale value you specify is for the lowest power scale in each direction***. If you are configuring three scales, the full scale values ***for the other two scales are fixed at x10 and x100 the full scale value of the first scale***. For example, if you specify a forward scale full scale value of 20 watts, with three forward power scales, your meter will support 0-20 watts, 0-200 watts, and 0-2000 watts for forward power. Likewise, if you specify a reflected scale full scale value of 5 watts, with three reflected power scales, your meter will support 0-5 watts, 0-50 watts, and 0-500 watts for reflected power. The built-in x10 rule is used by many of the meter movement manufacturers, which should allow you to reuse meters from some of that unused equipment lying around the shack.

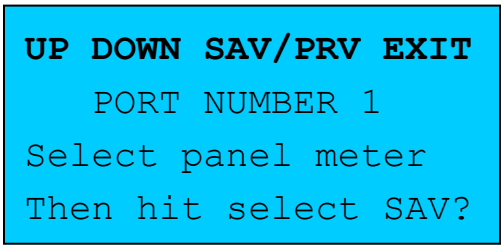
Note that most of the MB-1's default settings are already set up for the 20 watt forward and 5 watt reflected scales used by the crossneedle meter supplied with MB-1. This will facilitate set up. In most cases, you will simply have to push the SAVE or SELECT menu buttons to select the default value.

1. Before beginning, adjust the left panel meter pots for Panel Meter ports 1 and 2 (crossneedle meters require adjustment of 2 pots) to approximately 20% of their maximum travel (i.e., close to the CCW stop point). This is a precaution to prevent possible meter movement damage during calibration.

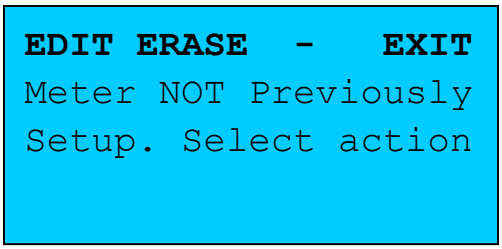
2. Bring up the Panel Meter Menu on line 4 of the LCD.

3. Hit the **Set-Up** button.

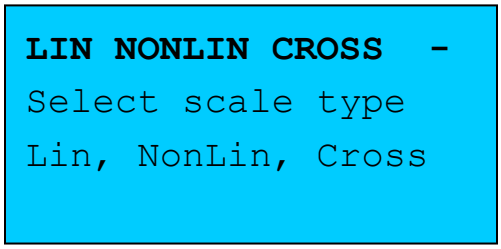
4. Select panel meter port 1 by pushing the UP/DOWN buttons (M1 and M2), then pressing SAV (M3) short press.



5. Select the EDIT function (M2). Edit applies to new calibrations as well as modifications being made to previously calibrated meters.



6. Select the meter movement type – Crossneedle (M3).



7. At this point, you will receive a message "ADJ MTR POT(s) PAST FS DEFLECTION." Adjust the port 1 and port 2 Panel Meter trim pots (***Crossneedle Meter – Internal***) on the left side of the MB-1 case to provide needle deflection of both needles ***past full scale***, without excessively overdriving the needle. This will allow you to program "soft overrange", which provides a safe degree of driving the needle past its full scale deflection point during an overrange condition.

8. After adjusting the side panel pots, "Hit any menu button" M1 – M4 to remove the drive from the meter.

9. Set the number of power ranges to 3 (default). (This single selection applies to both the FWD and REFL scales for crossneedle meters).

10. Set the Forward Power (lowest scale) to 20 watts (default).

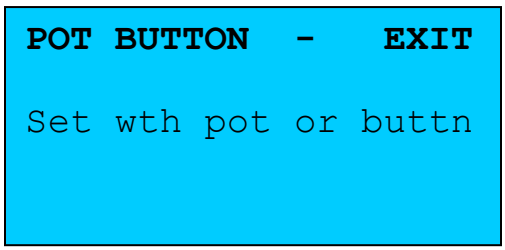
11. Set the reflected power (lowest scale) to 5 watts (default).

12. Set the soft overrange value to 5% (default).

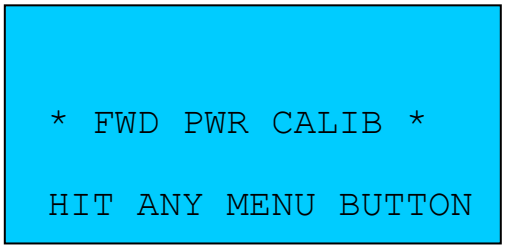
13. Set the number of forward power scale points to 2 (default).

14. Set the number of reflected power scale points to 2 (default).

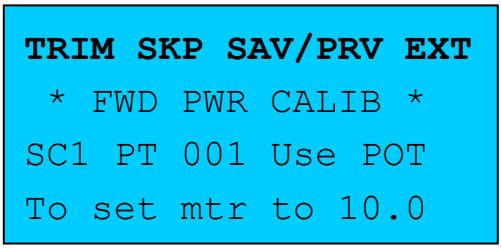
15. Select either the pot (M1) or UP/DOWN buttons (M2) to perform the actual calibration. This is a matter of personal choice. For this example, we will use the pot. Select the pot (M1).



16. Prompt to proceed with FWD scale calibration.

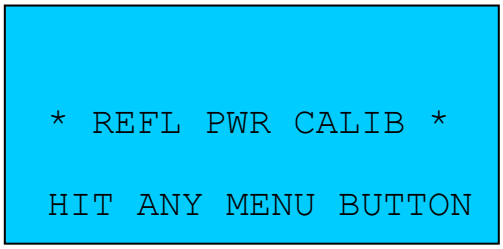


17. FWD calibration now starts. Using the pot, adjust the first forward power point to read 10.0 on the meter face on the FWD scale. Then hit SAVE ((M3 short press).



18. Repeat this for the 20.0 watt point.

19. Prompt to proceed with REFL scale calibration.



20. REFL calibration now starts. Using the pot, adjust the first Reflected power point to read 2.5 on the meter face on the REFL scale. Then hit SAVE ((M3 short press).

```
TRIM SKP SAV/PRV EXT
 * REFL PWR CALIB *
SC1 PT 001 Use POT
To set mtr to 2.50
```

21. Repeat this for the 5.0 watt point.

22. Trim function (optional) is used below to fine tune the adjustment made by the front panel pot with the UP/DWN buttons (vs. the pot). This should not be needed except possibly for extremely large meter scales where the UP/DWN buttons provide the equivalent of a "nudge" function. In most cases, you will find that the front panel pot provides adequate resolution.

```
UP DOWN SAV/PRV EXIT
  DtoA Value = 945
SC1 PT 001 Use UPDWN
to set mtr to 10.00
```

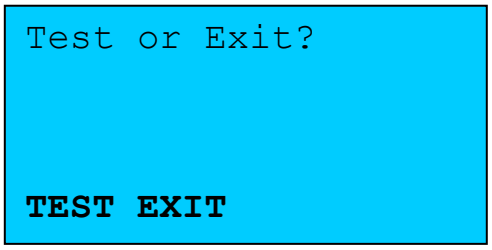
23. After all points have been calibrated, you will be prompted to save the settings to EEProm. Save Settings by pressing M1.

```
SAVE   -   -   EXIT

 SAVE ALL SETTINGS?
```

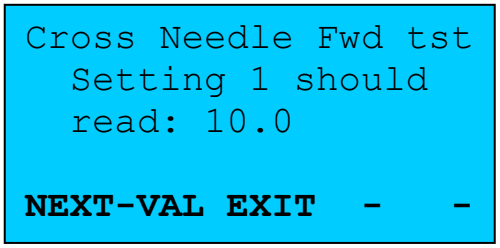
24. Settings Saved Confirmation message. Calibration is now complete.

```
SAVE   -   -   EXIT

METER CALIBRATION
VALUES SAVED.
```

25. When given the choice to TEST or EXIT, select TEST (optional) in this example. This will allow you to test the calibration.



26. **Testing the Calibration:** Each push of the NEXT-VAL button will advance the FWD needle to the calibration points as specified on the LCD screen. After all FWD points are exercised, the REFL needle is tested in an identical fashion. This allows you to verify the accuracy of every calibration point.



• • •

Testing Panel Meter Calibration:
You can activate the panel meter test procedure described above **at any time** by selecting the panel meter of interest by activating the Panel Meter menu on line 4 with the **PanMtr** shortcut button, selecting the Panel Meter number of interest, and then pushing the **DISP** button. Summary information will first be given for the selected panel, along with the option to run the panel meter TEST calibration described above.

8.7 Editing Panel Meter Calibration

You can edit one or more Panel Meter calibration points at any time without going through the entire calibration procedure. To edit a previously calibrated meter:

1. Bring up the Panel Meter Menu on line 4 of the LCD.
2. Hit **Set-Up**.
3. Select the panel meter you wish to edit by pushing the UP/DOWN buttons.
4. Select the EDIT function.
5. Each push of the **SAV** button will advance one calibration point ***without changing the previous calibration value***. Once you have reached the point(s) you wish to modify, press the UP/DOWN button (nudge function) to adjust the needle calibration (***the pot is***

not available for making adjustments in the edit mode). Then press SAV to save the new value(s). Note – holding down the UP or DOWN buttons will cause the needle to advance quickly. Pushing the UP or DOWN button one short push at a time provides a fine tune "nudge" function.

6. Continue the above process until you have advanced through all calibration points. (***Again, when editing a previously performed Panel Meter calibration, just press SAV at a calibration point without first pressing the UP/DOWN buttons to effectively skip over that calibration point leaving the calibration data for that point unaffected***).

7. Save the final settings by pushing the SAV button.

8. As in the original calibration, after saving the settings, you are given the option to TEST the new calibration or to EXIT.

9. Editing is now complete.

Note – If your meter has two scales (e.g., a nonlinear meter with a power and SWR scale, or a crossneedle meter), the above procedure requires that you to "visit" every point on both scales. Repeated pushes of the SAV button will quickly advance you through the points you wish to skip. If you overshot the point you want to change, you can press the **PRV** button ((M3 long press) to back up to the point you want.

8.8 Panel Meter Calibration Error Messages

During panel meter calibration, the software performs sanity checks on the calibration data, and issues error messages if it finds a violation. The DAC values that are saved at each calibration point are expected to be monotonically increasing. For example, for a meter scale that requires multiple calibration points (nonlinear or crossneedle), assume that the 5 watt point on a panel meter was calibrated, and the corresponding DAC value for the 5 watt point was 612. Now assume that you attempt to calibrate the 10 watt point. Because this is a higher power point, the software expects the ADC value for the 10 watt point to be higher than 612 (the DAC value for the 5 watt point). If this rule is violated, an error message will be displayed on the LCD.

When an error is encountered, you should correct the source of the problem (e.g., make sure the needle is pointing to the current point on the meter face). When you receive a calibration error message, hit any one of the four menu buttons. This will clear the error message and allow you to continue.

If the error is caused by a faulty calibration at a higher or lower power level, you can select the faulty power level (you advance to higher points by pressing SAV, and go back to lower points by pressing PREV (long press)). Then delete the faulty calibration point using the DEL menu button (short press). For panel meter calibrations, ***during the initial calibration*** (vs. an edit) you can only go back to previously calibrated points (with the PREV button). You cannot advance beyond the current calibration point until that point is first calibrated. In the EDIT mode, you can move both forward and backward (SAV and PREV) to any previously created calibration point to modify it.

Error Messages:

1. **INVAL CAL AT THIS PT**– You attempted to save a calibration point, but the DAC value violates the monotonically increasing rule (e.g., You calibrated two points, and the DAC value for calibration point 1 is higher than the DAC value for the calibration point 2).

9 Default Settings

The following table shows the factory default settings. The default settings may be restored any time with a long push of the **Backup** button. (Note, this is different than the full system initialization described in section 12 since this operation does not modify any of the Coupler calibration tables as does the full system initialization.

Table 17- Default Settings

Couplers		
Setting	**Default Value**	**Notes**
Real or Virtual Coupler Banks	Virtual Coupler Bank	
Coupler Number	5	First Virtual Coupler
Preloaded Coupler Settings	Coupler 1 – Multipoint Preset Calibration Table for included MB-HF1 Coupler	
	Coupler 2 – Quick Setup – Low Sensitivity	
	Coupler 3 – Quick Setup – Medium Sensitivity	
	Coupler 4 – Quick Setup – High Sensitivity	
Panel Meters		
Setting	**Default Value**	**Notes**
Panel Meter Number	1	
Panel Meter AutoRange	OFF	
Panel Meter Mode	OFF	
Number of FWD Power Ranges	3 (20 watts, 200 watts, 2000 watts)	
Number of REFL Power Ranges	3 (5w, 50 watts, 500 watts)	
FWD Power Range	R1 (Range 1 - Low Range) 20 watts	The default virtual coupler (5) has a full scale value of 20 watts, which is compatible with this Panel Meter setting.
REFL Power Range	Tracks FWD power range	
Peak Hold Delay	1 second	Applicable only when Panel Meter is measuring Peak Power.

AutoRange down-range delay	1 second	Applicable only when Panel Meter is AutoRange mode.

7 Segment Displays

Setting	Default Value	Notes
Display Module 1	TUNE (Instantaneous power) Leading zeros on	
Display Module 2	Peak Power Leading zeros on	
Display Module 3	Off	
Display Module 4	Off	

Bar Graph

Setting	Default Value	Notes
Bar Graph Output Device	Internal (LCD)	
Display Mode	Average Power	
Bar Graph AutoMax	On	
Sticky bar (peak hold on Bar Graph)	Off	
Bar Graph Manual Power Ranges (in watts)	20, 50, 100, 200, 2000	
Bar Graph Manual SWR Ranges	3, 5, 10	

LCD

Setting	Default Value	Notes
LCD FWD Power Measurement Mode	Tune (instantaneous) power	Appears on LCD line 2, Left side item.
Peak Power Mode - Forward or Delivered (FWD – REFL))	Forward	
Line 3 Display	Display REFL power and SWR on line 3 of LCD	

Averaging Filter

Setting	Default Value	Notes
Averaging Window	3.0 seconds	
Snap Average Reading	Off	

to Constant Signal		
Delay to snap AVG when Constant Signal detected	NA when Snap feature is off	

Band Compensation

Setting	Default Value	Notes
Band	Reference Band (80 meters for virtual couplers)	
Show Band Correction Factor in real time when Band Menu is displayed	On	

SWR Alarm

Setting	Default Value	Notes
Protection	Off	
Triggered Device(s)	Relay	
Minimum Power to enable SWR Calculation and Trip	1.0 watt	
Trip Interval (for Min and Max Power trip conditions)	2 seconds	
Reset Mode	Auto Reset	
Auto Trip Reset Interval	10 seconds	
Snooze Delay	20 seconds	
SWR Trip Point	3.0	
SWR Warning Level	2.8	
SWR Low Power Point	Ignore	
SWR High Power Point	Ignore	
"SWR Changing" Indicator	Off	

Demo Mode (Simulator)

Setting	Default Value	Notes
Mode	Off	
Type	3 Virtual Power Couplers (Couplers 5 - 7) 1 Virtual RF Ammeter Coupler (Coupler 8)	

Virtual Coupler Settings for use with Demo Mode Feature

Coupler 5	20 watts full scale SWR = 3.0 Band Compensation for 6 meters and 10 meters	
Coupler 6	200 watts full scale SWR = 2.0 Band Compensation for 6 meters and 10 meters	
Coupler 7	2000 watts full scale Variable SWR (2.5 – 3.5) Band Compensation for 6 meters and 10 meters	
Coupler 8 (Virtual RF Ammeter coupler)	20 amps full scale	

External Display Devices

Setting	Default Value	Notes
Configuration	Rear IDC Output Jacks configured for one external 7-Segment display (EXT-1) and one external Bar Graph module (EXT-2). 7-Segment module is configured for **TYPE A** device.	
External 7-Segment Display	Off	
External bar Graph Module	Off	

Miscellaneous

Setting	Default Value	Notes
Screensaver	On Delay = 4 minutes	
Display Brightness	LCD Brightness - 5 7-Seg Brightness - 6 LCD Contrast - 6	
Constant (Steady State) Signal Indicator	On	
Display Update Rates (1 -9)	Numeric Displays - 2 Bar Graph - 4 Panel Meter - 5	
Active Menu	Demo (Simulator)	

10 Updating the Firmware

To upgrade MB-1 firmware, you will need to download ***TeraTerm***, a free terminal emulator. The MB-1 bootloader makes use of the macro execution capability of TeraTerm. Macros have been written for the bootloader function and for the EEProm backup/restore/update utilities.

MB-1 firmware is upgraded by downloading a zip file from the MeterBuilder web site, unzipping the download archive into an empty directory, and then executing the TeraTerm macro that is included in the zip archive. The macro coordinates the handshaking between the MB-1 bootloader and the PC to install the new firmware.

You can obtain TeraTerm from here. You need TeraTerm version 4.64 or later.

New MB-1 software releases are available from www.meterbuilder.com. Releases are in zip file format. Download the desired release into an empty folder and unzip it. The zip file contains two files:

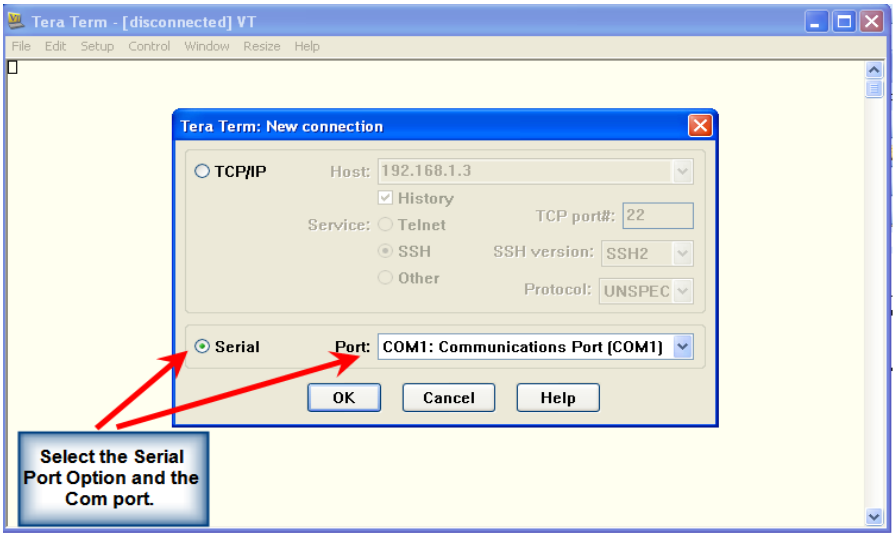
- **mb1_loader.ttl** - TeraTerm Bootloader macro
- **mb1.hex** - binary file that contains the updated firmware

Detailed Steps:

1. Connect the serial port cable from your PC to the DB-9 connector on the rear of MB-1.

2. Start up TeraTerm on the PC. Select the Serial Port option from the first start up screen; select the COM port used by your PC, and the other serial port options as shown below.

Figure 23 - TeraTerm Startup Window



From the TeraTerm **Setup** menu, set up the serial port options as follows:

Menu: Setup -> Serial port

- Settings:
- Port: COM1 (or to the active COM Port on your PC)
- Baud rate: 115200 (the items in black font are the default values and do not need to be changed).
- Data: 8 bit
- Parity: none
- Stop: 1 bit
- Flow control: none
- Transmit delay: char: 0, line: 0

Figure 24 – TeraTerm Setup Menu

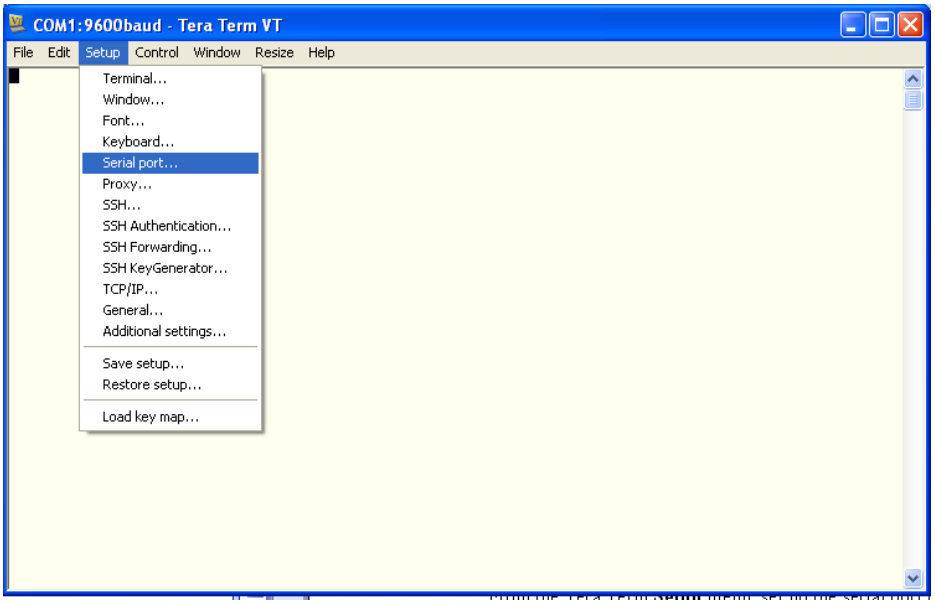
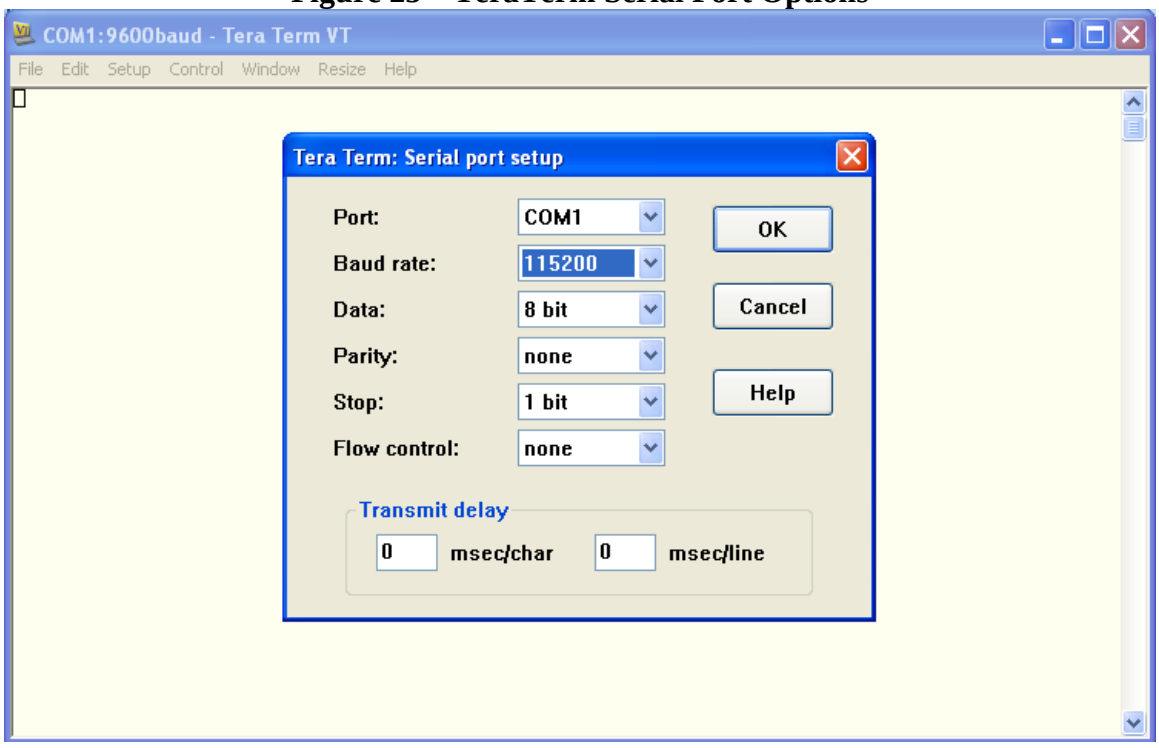


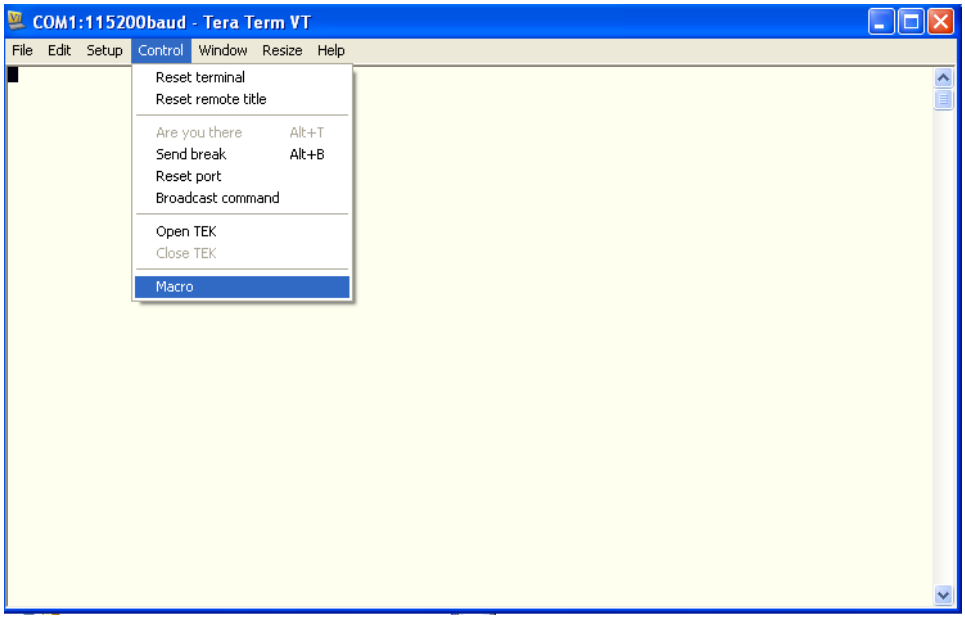
Figure 25 – TeraTerm Serial Port Options



3. Power down your MB-1. Turn power back on while holding in the M1 button. This causes MB-1 to enter the bootloader routine. The green LED on the **PanMtr** (bottom left) switch will turn on to confirm that MB-1 is in the bootloader mode ready to load the new firmware.

4. Execute the TeraTerm macro that was contained in the download. This is done from the TeraTerm **Control -> Macro menu**. Browse to the folder where you unzipped the download containing the new MB-1 release. Double click on the macro file (**mb1_loader.ttl**). Once the macro starts to execute, it will give you the option to "Load New Firmware?" Select YES to proceed, NO to abort. Sample screens are given below.

Figure 26 – Browsing to the TeraTerm Bootloader Macro



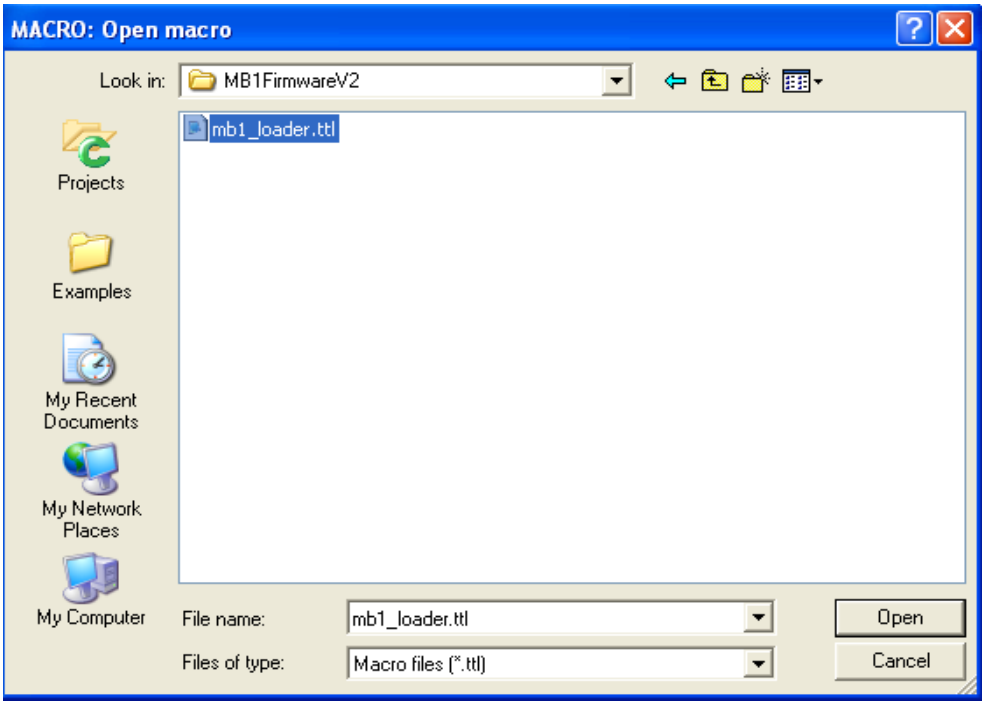
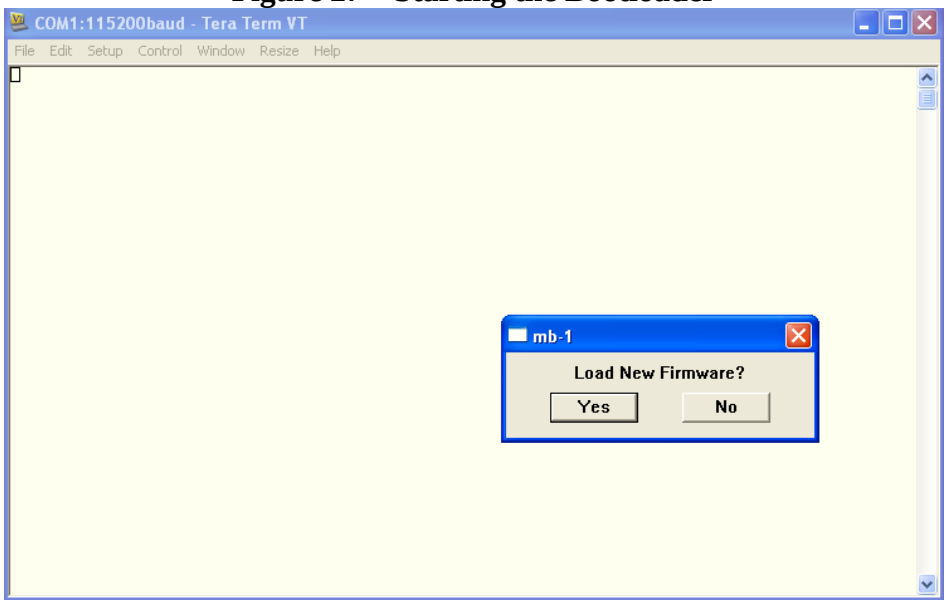


Figure 27 – Starting the Bootloader



5. The process takes about five minutes. The green LED on the **PanMtr** switch will flash continuously while the new firmware is being loaded, and the TeraTerm macro running on the PC will display a series of "A" (acknowledgement) characters for each line that is successfully loaded from the PC to MB-1. The macro will display a completion message when the process has finished.

   After the upgrade is complete, an integrity check is performed on the newly flashed program memory that has just been updated. If this check passes, the new software will begin to run immediately. If the bootloader detects one or more errors in the updated firmware, the yellow LED on the panel meter will light, and the beeper will emit a short beep to announce the error condition. If this occurs, repeat the firmware update procedure.

10.1 Troubleshooting

The TeraTerm macros developed for use with MB-1 have error checking. If an error occurs, check the following:

Table 18 -Troubleshooting PC-Based Utilities

Error Message	Possible Cause
mb1.hex file not found	The **mb1.hex** file, which contains the new software image, was not found in the same folder as the TeraTerm macro. Unzipping the MB-1 download should have placed both the mb1.hex file and TeraTerm Bootloader macro, **mb1_loader.ttl**, in the same folder. If not, check you zip tool options.
Timeout on line N	PC and MB-1 are not communicating. Check the serial port settings. If this does not resolve the problem, verify connectivity to the PC by running the MB-1 Self Test Routine (section 3.18). Two of the self test procedures determine whether the MB-1 and the PC are communicating properly.

11 Backing Up, Restoring, and Updating EEPROM Settings and Tables

All of the MB-1 settings, Coupler calibration tables, and Panel Meter calibration tables are stored in EEPROM. Once you have spent some time in setting up MB-1, consider backing up the EEPROM settings to a PC file. This will allow you to easily restore your settings if, for example, you inadvertently erase a coupler table or Panel Meter table. The utilities also include an OEM update utility that will load the latest version of preconfigured OEM Coupler calibration tables into EEPROM.

In the MB-1 design, EEPROM is divided into two sections: ***User Data*** and ***preloaded OEM coupler calibration tables***. Any configuration changes you make, including calibration of any of the four couplers and five panel meters (max), are stored in the ***User Data section of EEProm data***. ***This is the data you want to back up so that your settings, including coupler and panel meter calibration tables, can be easily restored.***

The Preloaded OEM Coupler Calibration Tables are stored in the OEM section of EEProm. These tables contain preconfigured calibration tables for the MB-HF1 coupler and some of the more popular couplers made by other manufacturers. If you are using one of these couplers, coupler setup is simplified if you use the preloaded OEM table during coupler setup. MB-1 comes preloaded with this data, but you may want to update the OEM table data as MeterBuilder adds to or updates these tables.

The MB-1 backup/restore firmware works in conjunction with TeraTerm macros developed by MeterBuilder. These macros are run on the PC and communicate with MB-1 during the backup/restore/update operation.

A summary of the utilities and the PC data files they operate on are given in the table below.

-

Table 19 - EEProm Backup, Restore, and Update Utilities

Function	**TeraTerm Utility name**	**PC filename of Data File**	**Option to Select from EEPRM --- Menu**
Back up **User data** section of EEProm ***to*** a PC file	**mb1_backup.ttl**	File **mb1_user.data *is created*** on the PC by this TeraTerm utility.	**EEPRM-BKP-U**
Restore **User data** section of EEProm ***from*** a PC file	**mb1_restore.ttl**	**mb1_user.data** (created from a previous backup) ***is read*** by this TeraTerm utility when restoring User Data section of EEProm.	**EEPRM-RST-U**
Update the **OEM Coupler Data**	**mb1_update.ttl**	Obtain the latest version of **mb1_oem.data** from	**EEPRM-RST-O**

Tables in EEProm ***from*** a file obtained from MeterBuilder web site.		the MeterBuilder web site. This file ***is read*** by this TeraTerm utility when updating the OEM coupler table section in EEProm.	

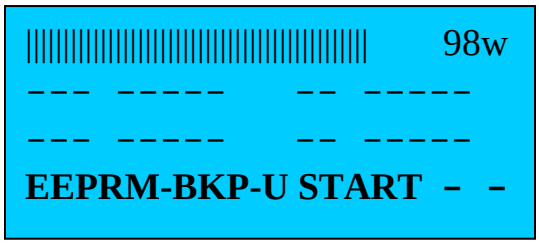
The Backup, Restore, and Update utilities can be obtained from the **Downloads** section of www.meterbuilder.com.

11.1 Backing Up EEPROM Data

Detailed Steps:

1. Follow detailed steps 1 and 2 in section 10 to set up the TeraTerm tool and to connect the PC serial cable.

2. Select the EEPROM Backup/Restore menu on MB-1 (section 3.11). Select the User Data Backup option **EEPRM-BKP-U (Backup User Data).** ***Press START*** (M2) ***at this point.*** You will see a "**Please Wait**" confirmation message on the LCD.



3. Now execute the Backup TeraTerm macro, **mb1_backup.ttl** that was contained in the download. This is done from the TeraTerm **Control -> Macro menu**. Browse to the folder where you unzipped the download. From within TeraTerm, double click on the backup macro file (**mb1_backup.ttl**). Once the macro starts to execute, it will give you the option to proceed. Select YES to proceed, NO to abort.

   If you pressed YES, this will initiate the backup process. You will see a series hex character lines displayed on the PC. This is the EEPROM data in hex format being sent from MB-1 and loaded into file **mb1_user.data** on the PC. The green LED on the PanMtr switch will also flash continuously while the EEProm data is being copied.

   At the completion, you will see a "DONE" message displayed on the MB-1 LCD,

and a completion confirmation message displayed from the macro on the PC. At this point, the backup file, ***mb1_user.data***, has been created on the PC. This is the file you will use if you need to do a restore operation. Remember its location for future use.

4. The backup is now complete.

11.1.1 Troubleshooting

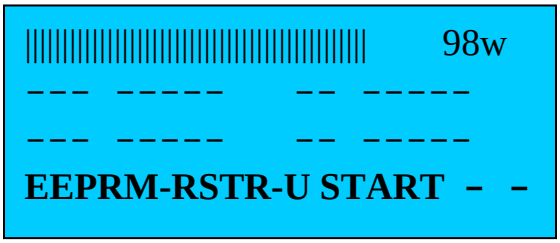
The general troubleshooting steps listed under the Bootloader operation (Table 18) are applicable here as well.

11.2 Restoring EEPROM Data

Detailed Steps:

1. Follow detailed steps 1 and 2 in section 10 to set up the TeraTerm tool and to connect the PC serial cable. Make sure the backup file, ***mb1_user.data***, which was obtained from a previous EEPROM backup, is in the same folder as the restore macro, mb1_restore.ttl.

2. Select the EEPROM Backup/Restore menu (section 3.11). Select the User Data Restore option **EEPRM-RST-U (Restore User Data).** ***Press START at this point.*** You will see a "**Please Wait**" confirmation message on the LCD.



3. Then execute the Restore TeraTerm macro**, mb1_restore.ttl**. This is done from the TeraTerm **Control -> Macro menu**. Browse to the folder where you unzipped the download. From within TeraTerm, double click on the restore macro file (**mb1_restore.ttl**). Once the macro starts to execute, it will give you the option to proceed. Select YES to proceed, NO to abort.

   If you pressed YES, this will initiate the restore process. You will see a series of "A" characters (acknowledgement characters) displayed on the PC while the utility is running. These are "handshake" characters that are sent from MB-1 to the PC after each line that is sent from the PC to MB-1 is successfully read. The green LED on the **PanMtr** switch will also flash continuously while the EEProm

data is being copied.

At the completion, you will see a "DONE" message displayed on the MB-1 LCD, and a completion confirmation message displayed from the macro on the PC. At this point, the restore operation is complete. MB-1 will now have all of the calibration tables and **ALL** configuration settings that existed at the time you performed the backup. ***After the restore operation is complete, you must power cycle the meter to cause the restored EEProm data to be loaded into working memory.***

11.2.1 Troubleshooting

The general troubleshooting steps listed under the Bootloader operation (Table 18) are applicable here as well.

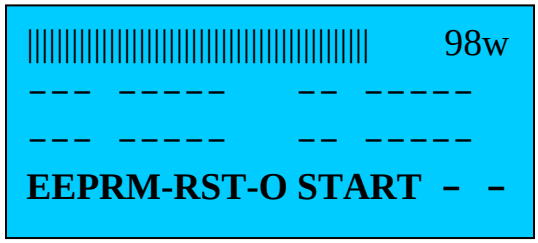
11.3 Updating EEPROM OEM Data Tables

Detailed Steps:

1. Follow detailed steps 1 and 2 in section 10 to set up the TeraTerm tool and to connect the PC serial cable.

2. Obtain the updated OEM data table, ***mb1_oem.data***, from the MeterBuilder website, and place it in the same folder as the update macro, mb1_update.ttl.

3. Select the EEPROM Backup/Restore menu (section 3.11). To update the OEM tables select OEM Data Restore option **RST-O (Restore (update) the OEM Data).** ***Press START (M2).*** You will see a "**Please Wait**" confirmation message on the LCD.



4. Now execute the Update TeraTerm macro, **mb1_update.ttl**. This is done from the TeraTerm **Control -> Macro menu**. Browse to the folder where you unzipped the download. From within TeraTerm, double click on the macro file (**mb1_update.ttl**). Once the macro starts to execute, it will give you the option to proceed. Select YES to proceed, NO to abort.

If you pressed YES, this will initiate the OEM table update process. You will see a series of “A” characters (acknowledgement characters) displayed on the PC while the utility is running. These are “handshake” characters that are sent from MB-1 to the PC after each line that is sent from the PC to MB-1 is successfully read. The green LED on the **PanMtr** switch will also flash continuously while the EEProm data is being copied.

At the completion, you will see a “DONE” message displayed on the MB-1 LCD, and a completion confirmation message displayed from the macro on the PC. At this point, the OEM update operation is complete. MB-1 will now have updated calibration tables that you can easily load by selecting the appropriate OEM code during calibration of any of the supported couplers as described in section 5.3.

11.3.1 Troubleshooting

The general troubleshooting steps listed under the Bootloader operation (Table 18) are applicable here as well.

12 Power-Up Configuration Changes

While powering up MB-1, various combinations of the four menu switches M1 – M4 may be pressed to perform various configuration changes, such as reinitializing MB-1 to its factory default settings, entering the bootloader, or changing a configuration for the external high visibility display devices. The complete list of operations that can be performed while powering up the meter is shown in the figure and table below.

Figure 28 - Power-up Configuration Changes

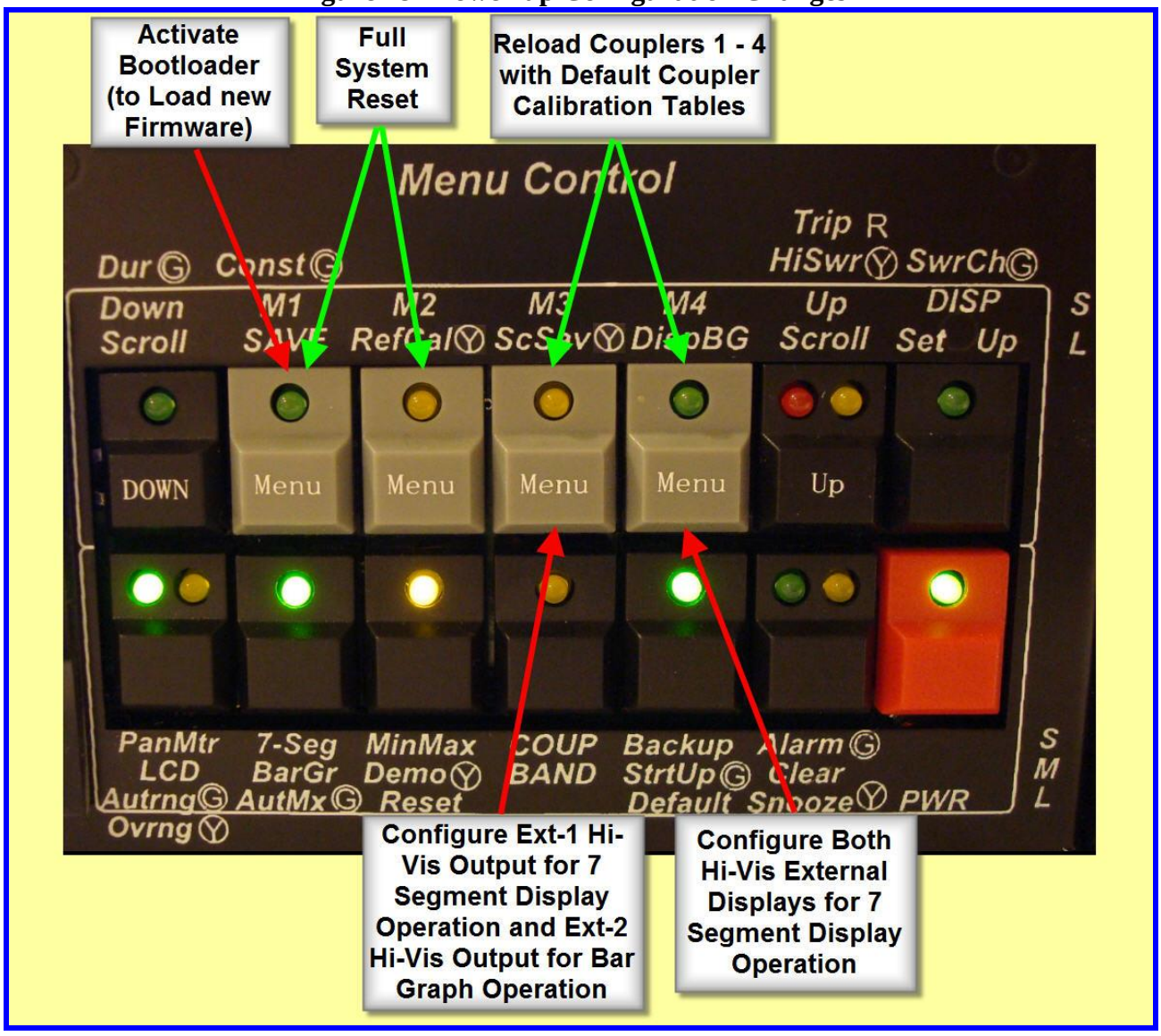


Table 20 - Power-up Configuration Changes

Operation	Hold Down the following Menu Buttons during Power-up
Initialization – Required to configure LCD character set, and to load coupler tables from the OEM section of EEPROM to User section of EEProm. This step must be performed once after kit assembly. All other settings (including Panel Meter calibrations) are maintained, except that the startup configuration set is set to the Default set. However, your startup settings (if previously saved) are still in EEProm, and may be restored as discussed in section 4.1.1.	M1 and M2
Enter the Bootloader (use when installing new firmware).	M1
Refresh the Coupler Tables to factory settings (Loads coupler tables from the OEM section of EEPROM). Leaves remainder of meter settings unaffected). Coupler Port 1 is loaded with the calibration table for the included MB-HF1 coupler. Coupler ports 2 -4 are loaded with single point "Quick Setup" power coupler profiles.	M3 and M4
External Displays - Configure one external Display port (EXT1) for use with a Hi-Visibility 7-Segment Display module and the other external Display port (EXT2) for use with the Hi-Visibility Bar Graph module. (This is the factory default).	M3
External Displays - Configure both external Display ports (rear panel of meter) for use with the Hi-Visibility 7-Segment Display modules.EXT1 maps to D5. EXT2 maps to D6.	M4

13 External 7-Segment and Bar Graph Display Modules

The MB-1 Expansion Kit comes with one external 7-segment display module (1.5 inch LEDs) and one external Bar Graph module. The Hi-visibility external 7-segment display module and external Bar Graph module are shown below. You must provide your own enclosure/case for these modules. (Two ribbon cable assemblies with connectors are provided to interconnect these modules to the rear connectors on MB-1).

Both types of external display modules (7-Segment and Bar Graph) have two IDC Jacks, J1 and J2. These modules get connected to MB-1 using the J1 jack. J2 is not used on the external display modules.

Figure 29 – Hi Visibility 7-Segment Display (2 pieces)

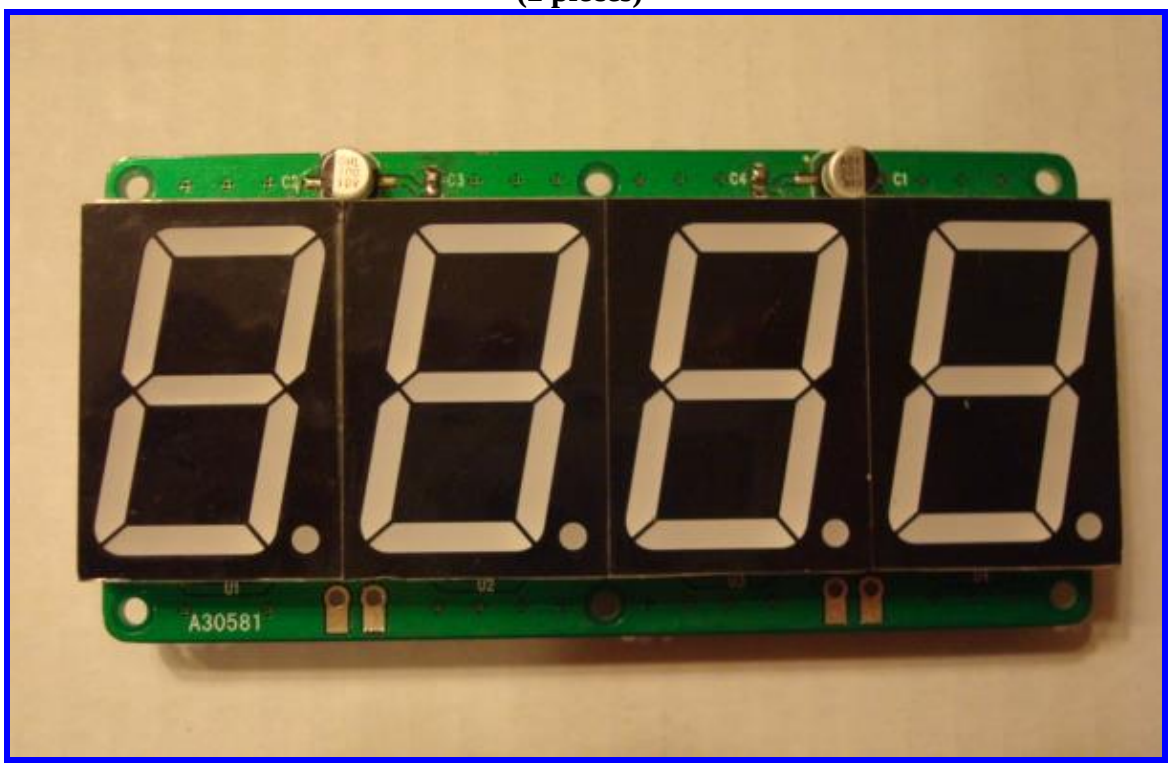
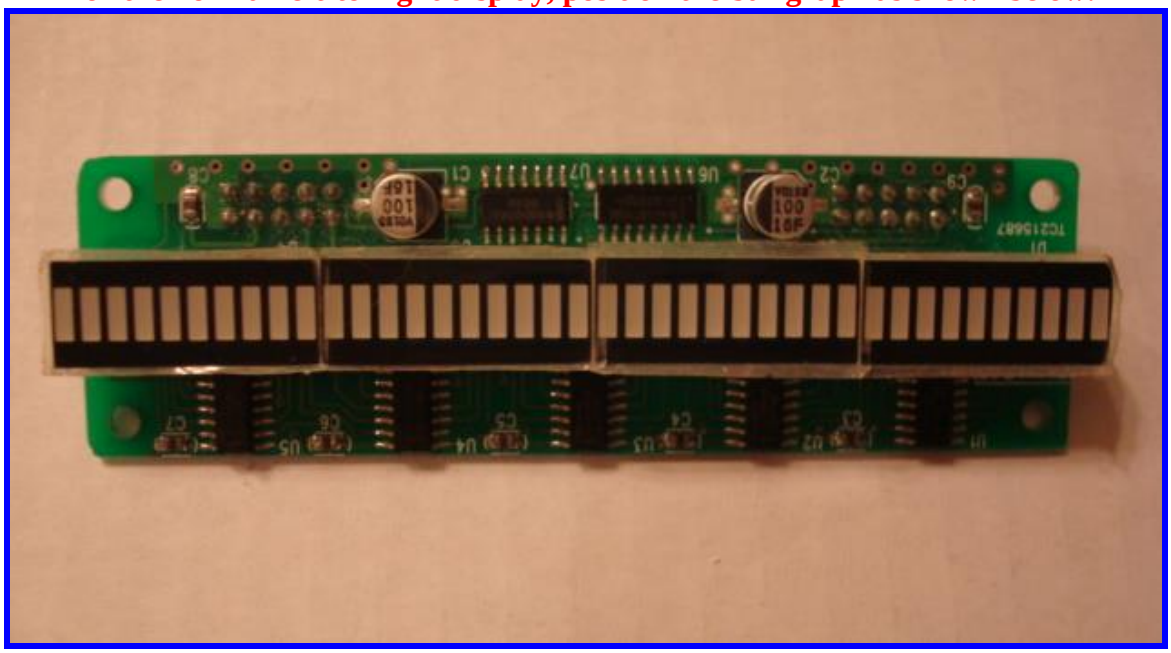


Figure 30 – Hi Visibility Bar Graph
(1 piece)
For the normal left-to-right display, position the bar graph as shown below.



You can connect a total of two of these devices to the ***EXT 1*** and ***Ext 2*** Jacks on the MB-1 rear panel (see Figure 3). You must configure MB-1 with one of the two configurations:

- Two External Hi Visibility 7-Segment Displays.
- One External Hi Visibility 7-Segment Display and one External Hi Visibility Bar Graph module (this is the factory default configuration).

This configuration change is done using the appropriate power up sequence described in **Table 20**.

The menu selections that control the 7-Segment display and Bar Graph will adapt automatically to these configurations changes. If you add two external 7-segment displays, you will be able to control 7-Segment Display modules 1 – 6 from the Digital (Seven Segment) Display Operation menu (modules 5 and 6 are the two external 7-segment modules that connect to the rear panel IDC jacks). (Note, the Expansion kit includes only one external 7-segment module.)

If you add one external 7-segment display and the external Bar Graph module, you will be able to control 7-segment Display modules 1 – 5 from the Digital (Seven Segment) Display Operation menu on line 4 of the LCD (module 5 will be the single 7-segment external module in this case).

When MB-1 is configured to work with the external Bar Graph module, the Bar Graph menu is also expanded to include additional choices for the external Bar Graph device. The **BGEXT** choice will cause the Bar Graph data to be displayed on the **ext**ernal Bar Graph Device only. The **BGBTH** choice will cause the Bar Graph data to be displayed on both the internal (LCD) Bar Graph and external Bar Graph.

13.1 Configuring the External Hi-Visibility Display Modules

The external 7-Segment LED module is a member of a family of other large 7-Segment displays manufactured by Sure Electronics, which sells modules **up to 7 inches in height**!

http://stores.ebay.com/Sure-Electronics

Do a store search for "Information Boards"

You can connect any of the SURE family of 7 segment devices (up to 7 inches) to MB-1. However, the voltage requirements and software drivers vary based on the device. To accommodate the different device types, you must set the voltage to 5 volts or 12 volts using a shorting pin on 3 pin headers on the Controller Board. Additionally, you must select the appropriate software driver by identifying the device type of an external 7-segment module.

For the external seven segment display devices (D5 and D6 as selected from the Seven Segment Display menu), you must identify the type of external device (A, B, C, or D) in field 4 of the menu (see 3.9) so that the correct software driver is used.

For purposes of terminology, we refer to the 1.5 inch 7 segment display module as a TYPE A device. All of the other SURE external 7-segment display devices, with the exception of the 7 inch modules, are TYPE B devices.

The largest (7 inch) modules will run as a **TYPE C** or **TYPE D** devices. If you set the 7 inch modules to **TYPE C** (which selects the software that is programmed according to the manufacturer's specs), you may notice a slight amount of flicker. If you find the flicker objectionable, set the type to **TYPE D** in the menu. This causes the software to use a modified driver that avoids the flicker but does so at the expense of some performance. In most cases, the performance impact will not be significant, but you should be aware of this tradeoff.

It is extremely important that you set the jumpers on the 3 pin headers - EXT 7SEG1 and EXT 7SEG2 - located on the Controller PCB to correspond to voltage required by the devices you are using for EXTernal module 1 and EXTernal module 2. Applying 12 volts to a TYPE-A module will likely destroy it, so be careful with this step.

The following table summarizes the voltage requirements and the TYPE options that must be selected for various types of external display devices:

Table 21- Power and 7-Seg Menu Options for External Hi-Vis Display Modules

Devices Connected to Ext 7-Seg 1 Connector on Rear Panel				
DEVICE	**Device Type**	**Set EXT7SEG1 Jumper to**	**Seven Segment Device Number (Field 1 in Seven Segment Menu)**	**Set Field 4 in Seven Segment Menu to:**

External BG Module	**NA**	**5 Volts**	**NA**	**Not Applicable** (External Bar Graph is controlled from Bar Graph menu)
1.5 inch 7-Segment Device	**A**	**5 Volts**	**5**	**A**
1.8 inch 7-Segment Device	**B**	**12 Volts**	**5**	**B**
2.3 inch 7-Segment Device	**B**	**12 Volts**	**5**	**B**
4 inch 7-Segment Device	**B**	**12 Volts**	**5**	**B**
7 inch 7-Segment Device	**C**	**12 Volts**	**5**	**C**
7 inch 7-Segment Device (Same as above but ***TYPE D*** menu choice avoids flicker if present)	**D**	**12 Volts**	**5**	**D**

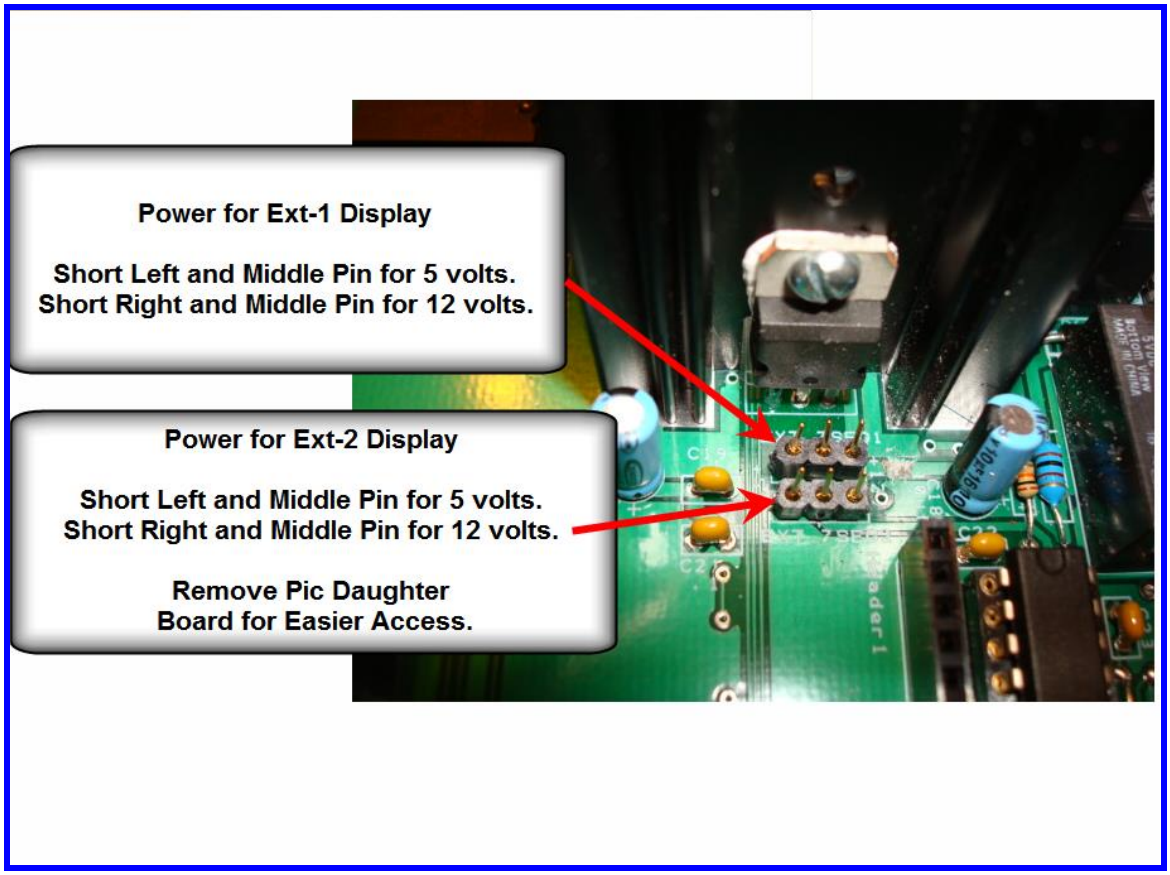
Devices Connected to "Ext 7-Seg 2 or Ext Bar Graph" Connector on Rear Panel				
DEVICE	**Device Type**	**Set EXT7SEG2 Jumper to**	**Seven Segment Device Number Set (Field 1 in Seven Segment Menu)**	**Set Field 4 in Seven Segment Menu to:**
External BG Module	**NA**	**5 Volts**	**NA**	**Not Applicable** (External Bar Graph is controlled from Bar Graph menu)
1.5 inch 7-Segment Device	**A**	**5 Volts**	**6**	**A**
1.8 inch 7-Segment Device	**B**	**12 Volts**	**6**	**B**
2.3 inch 7-Segment Device	**B**	**12 Volts**	**6**	**B**
4 inch 7-Segment Device	**B**	**12 Volts**	**6**	**B**
7 inch 7-Segment Device	**C**	**12 Volts**	**6**	**C**
7 inch 7-Segment Device (Same as above but ***TYPE D*** menu choice avoids flicker if present)	**D**	**12 Volts**	**6**	**D**

You can mix and match TYPE A, B, C, and D devices as long as you observe the rules specified in the above table with respect to voltage settings and protocol settings (TYPE A, B, C, or D). Remember that the External Bar Graph Module can only be connected to the "**Ext 7-Seg 2 (EXT 2)** connector (the leftmost ICD connector on the rear panel when looking at the rear panel).

Cascading SURE Modules:
Note that the 4 inch SURE 7-segment module comes in two digit configurations, so ***you will have to cascade two of these*** together for a 4 digit module. Likewise, 7 inch SURE 7-segment module comes in a single digit configuration, ***so you will have to cascade four of these*** together for a 4 digit module. Also, the 7 inch unit has 3 dots to the right of the numeric segments. You will have to configure switch M1 on each of the 7 inch SURE devices to enable only the bottom dot, which is used as the decimal point. Cascading multiple units is easily done in a simple daisy chaining arrangement and is explained in the SURE manuals for these devices.

The following figure shows an example of setting the shorting pins on the two- 3 pin headers for controlling the voltage to each of the external modules. In the figure below, **Ext 7-Seg 1 Connector is configured for a type B device (12 volts), and Ext 7-Seg 2 Connector is configured for a type A device or External Bar Graph (5 volts).**

Figure 31 – Header Power Connections for External Hi-Visibility Modules



13.2 Current Consumption and Fuse Ratings

MB-1 comes with a 1.6 amp fast blow fuse, which is rated for maximum power use of the base meter, one external 1.5 inch 7-segment module, and one external Bar Graph module. Replace the fuse with a fast acting fuse of the same rating (fuse dimension = 5 x 20 mm).

If you connect heavier current devices to the external display jacks, you will have to change the fuse to one with a higher current rating. The following table will help in determining the fuse size. You can use the maximum calculated current from the table below based on the types of devices you plan to connect to the external display jacks. The values in the table were determined empirically by setting the devices to their maximum current state (e.g. 888.8. for 7 segment devices, and all 40 bars lit for external Bar Graph module). After calculating the maximum current, derate the fuse to 70%, meaning that:

Rating of the fuse * .70 = Actual max expected current

Choose the next highest amperage fuse.

Alternatively, you can temporarily remove the fuse and insert an ammeter across the fuse terminals. Measure the actual current with all on-board and external devices enabled, and with the brightness and contrast settings set to the maximum values. Then apply the derating factor. Choose the next highest amperage fuse.

Table 22- Current Consumption (measured values)

Module	Max Current
Base Meter, no external display devices (configured for max power consumption)	860 mA
External Bar Graph	300 mA
1.5 inch external 7-segment SURE module	200 mA
1.8 inch external 7-segment SURE module	330 mA
2.3 inch external 7-segment SURE module	300 mA
4 inch external 7-segment SURE module (2 modules cascaded)	320 mA
7 inch external 7-segment SURE module (4 modules cascaded)	2.4 amps (Requires Auxiliary 12 volt Power See Figure 33)

13.3 Auxiliary Power for 7 inch External 7-Segment Modules

As you can see from the table above, the 7 inch 7-segment external display devices require too much current to supply directly from MB-1. Fortunately, these devices have an Auxiliary Power connection on each module that is readily accessible (see Figure 32), and can be fed from an auxiliary 12 volt power module (3 amps with fuse protection recommended).

The 7 inch display modules have diodes to prevent back feeding of the auxiliary power back into the MB-1 5 volt or 12 volt power normally supplied on the IDC cable from MB-1. **However, when using the 7 inch modules, we recommend removing power from the EXT-7SEG1 or EXT-7-SEG2 headers by removing the jumper pin(s) to ensure that the MB-1 power buses will be totally isolated from the rear panel IDC connectors thereby preventing any possibility of damage to the MB-1 Control head.**

(Note the other 7-segment external display modules (1.8 inch – 4 inches) can also be powered with external power, ***but these units have no protection diodes. Use an***

auxiliary power source for the 7 inch modules only, and power all other units directly from MB-1 12 volt supply).

Figure 33 below shows a block diagram of the Auxiliary Power Arrangement for the 7 inch display modules.

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Figure 32 – Auxiliary 12 volt Power Connection for 7 inch External Displays

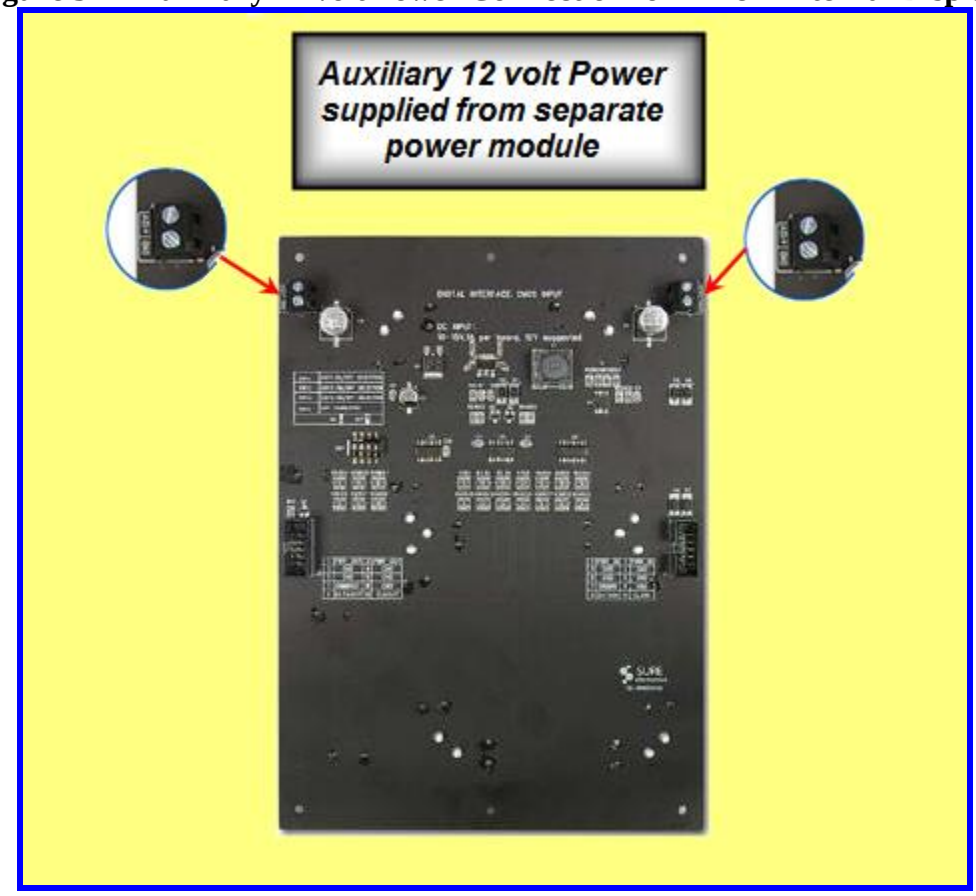

Figure 33- Auxiliary Power Connections for 7 Inch External Displays