MFJ-203 Bandswitched Dip Meter™

Thank you for purchasing the MFJ-203 Bandswitched Dip Meter™. The MFJ-203 Bandswitched Dip Meter™ is a solid state bandswitched adaptation of the traditional grid dip meter. MFJ replaced the external tuning coils, which are lost or misplaced, with a bandswitch. The MFJ-203 uses one external coil to *couple* to the circuit under test. Using the MFJ-203 you can make several measurements. Read the resonant frequency of a tuned circuit or antenna directly from the Tune scale. Find the value of an unknown capacitor or inductor. Measure 1/4 wave frequencies or velocity factor of a feed line. Find the approximate Q of a resonant circuit or RF inductor. The MFJ-203 can also be used as a signal generator.

The MFJ-203 covers all ham bands from 10 meters to 160 meters. The dial calibration is approximate and for reference only. The actual frequency may vary from what is marked on the front panel. Approximate frequency coverage is as follows.

Band A	1.75 to 3.2 MHz
Band B	3.2 to 6.1 MHz
Band C	6.2 to 12.2 MHz
Band D	11.7 to 23.1 MHz
Band E	17.3 to 34.8 MHz

A frequency counter can be connected to the FREQ. OUT jack (RCA phono) to get a more accurate reading of the frequency. As an alternative to a frequency counter, you can zero beat the output with an HF receiver. See the section on zero beating the MFJ-203 with a receiver.

The MFJ-203 requires a DC power supply adapter or a nine-volt transistor battery. Any 9 to 12 volt, 100 mA, filtered and fused, DC power supply may also be used by connecting a 2.1 mm plug to the cable with the positive wire connected to the center pin and the ground wire connected to the shield. The MFJ-1312B is available from MFJ for $12.95

CAUTION: Always use an ALKALINE nine-volt battery with this unit. Never use ordinary carbon-zinc batteries that may leak and damage this unit.

To install a nine volt battery, remove the screws holding the cover onto the case. Insert the battery into the battery holder. Tuck the battery snap wires out of the way so they do not interfere with the tuning capacitor rotation. Re-install the cover and screws.

MFJ-203 Theory of Operation

The MFJ-203 Bandswitched Dip Meter is a very versatile piece of equipment. It can be used to make accurate measurements of many different RF circuits when properly used. The following operating description will help you get the maximum accuracy and versatility from the MFJ-203.

The MFJ-203 contains an internal bandswitched oscillator circuit. The oscillator is buffered to increase the signal level and prevent the load from affecting the oscillators frequency. The high level RF output signals covers all HF ham bands and is available on the COUPLING COIL jack and the FREQ. OUT jack.

The MFJ-203 also contains a meter that is used to measure the amount of RF energy in the output circuit. As more signal is removed from the coupling coil the meter reads a lower amount (towards zero).

By plugging a small coil into the coupling coil jack, the MFJ-203 can be used to test external circuits for coupled signal induction. The magnetic field surrounding the coupling coil provides the required connection or coupling to the circuit under test. The meter on the MFJ-203 is then used to measure the amount of RF signal coupled into the test circuit. The lower the meter reading the more signal absorbed by the test circuit.

Any resonant circuit will absorb RF from the coupling coil of the MFJ-203 as long as the circuit is tuned to the same frequency as the oscillator of the dip meter. As the "Q" of the circuit measured increases the dip will become sharper and deeper because high "Q" circuits absorb more RF energy in a narrow range of frequencies.

Unlike the tuning coils of the conventional grid dip meter, the coupling coil of the MFJ-203 is ***not*** a part of a resonant tank circuit. The MFJ-203 depends on the Q of the external circuit to improve the circuit coupling. If the external circuit has a very low Q, the coupling will have to be increased by placing the inductor of the external circuit very close and in line with the axis of coupling coil. This has the advantage that stray coupling is reduced and frequency pulling of the oscillator is eliminated, so resonant frequency readings can be made with more precision.

To insure accurate readings always keep the coupling as loose as possible while still getting a readable dip.

Maximum coupling is obtained when the MFJ-203 coupling coil is either placed inside a larger coil under test, placed against a coil of equal size or placed over a coil of small size. Once the dip is found the coils should be separated until the dip is barely evident.

The coupling coil can be removed and the coupling coil jack can be used to directly feed a one or two turn link coil on a toroidal inductor. The coupling can be easily varied when testing resonant circuits containing toroids by adding or removing turns from the coupling link. ***Never try to couple toroids with the standard method of using a double link***. The air wound external link acts like a shorted turn on the toroid and lowers the inductance. This makes conventional grid dip meters inaccurate for measuring many types of toroids.

Coaxial cable or twin lead feedlines can be measured for resonance by coupling the cable to the MFJ-203 with a short piece of wire that connects to the conductor of the feedline (the shield and the center conductor). This link is then slipped over the coupling coil of the MFJ-203. Coaxial lines can also be measured by plugging the coaxial line directly into the Coupling Coil jack.

The MFJ-203 is supplied with some standard value RF capacitors and inductors for measuring the value of components.

Using The MFJ-203 Bandswitched Dip Meter™

Caution The frequency tolerance of the front panel markings and the accuracy of all measurements can vary up to 20% unless an external frequency measurement device is used to calibrate frequency readings. This device is stable enough to make a field measurement and return to a test bench to make a reading from the FREQ. OUT jack as long as the Tune knob is not jarred or turned. See zero beating the MFJ-203.

Finding the resonant frequency of a tuned circuit.

1. To check the resonant frequency of a tuned circuit, remove all power from the circuit under test.

2. Turn the Band switch to the band you want to test.

3. Place the meter's coil near the circuit to be tuned (see theory of operation). Turn the Tune knob until the needle fluctuates.

4. Slowly turn the Tune knob back and forth very slowly until the needle is at it's minimum deflection.

5. Read the approximate frequency from the Tune scale or measure the exact frequency with a frequency counter or receiver.

Determining electrical quarter wavelength and velocity factor of transmission lines.

1. Disconnect both ends of the transmission line to be measured.

2. Connect a two turn loop from the shield to the center conductor of one end. Use a short clip lead not more than 6 inches long or connect the coax directly to the Coupling Coil jack on the MFJ-203.

3. Put the coupling coil into the two turn loop.

4. Find the ***lowest*** frequency across all the bands at which a deep dip occurs.

5. Read the frequency from the Tune scale or a frequency meter. This is the 1/4 wavelength frequency of your transmission line. To get the 1/2 wavelength frequency double your 1/4 wavelength frequency measurement. Note that you will get a dip at higher frequencies at all odd 1/4 wavelengths.

6. Divide 246 by the measured dip frequency. This gives you the free space 1/4 wavelength in feet.
   Example: 246 divided by a dip frequency of 7.3 MHz is 33.7 feet, the free space 1/4 wavelength

7. Divide the actual measured length of the feedline in feet by the free space 1/4 wavelength measured in number 6.
   Example: 27 feet (actual length) divided by 33.7 feet (free space) equals .80 . The velocity factor is .80 or 80%.

$$\text{Free space } 1/4 \text{ wavelength} = \frac{246}{\text{dip frequency}}$$

$$\text{Velocity Factor} = \frac{\text{Free space } 1/4 \text{ wavelength}}{\text{Actual feedline length}}$$

Measure capacitance.

Note: When using the MFJ-203 to measure capacitance, readings will be the most accurate if the standard test inductance used is between 0.5µH to 1000µH. The range of accurate capacitance will then be between 10 pF and .01 µF.

1. Connect an unknown capacitor in parallel with the highest value standard inductor.

2. Insert the inductor inside the coupling coil centered and parallel to the coil windings.

3. Adjust the tune knob through the bands until you get a large dip. If you do not get a deep meter deflection change to the next inductor with a lower value and try again. Continue the process until you obtain a dip.

4. Solve this equation using F as the resonant frequency as L as the inductance of the standard inductor,

$$C(pF) = \frac{1}{.00003948F^2L}$$

Measure inductance.

Note: When using the MFJ-203 to measure inductance, readings will be the most accurate if the standard test capacitance used is between 10 pF and .01 µF. The range of accurate inductance will then be between 0.5µH to 1000µH.

1. Connect an unknown inductor with the highest value standard capacitor in parallel.

2. Insert the inductor inside the coupling coil centered and parallel to the coil windings.

3. Adjust the tune knob through the bands until you get a large dip. If you do not get a deep meter deflection change to the next smaller value standard capacitor and try again. Repeat the process until you get a deep dip.

4. Solve this equation using F as the resonant frequency and C as the capacitance of the standard capacitor.

$$L = \frac{1}{.00003948F^2C}$$

Measure coefficient of coupling of two resonant circuits.

1. Measure the resonant frequency at one coil and record it as Fs. This is a measurement of the resonant frequency of both circuits in their coupled state.

2. Make a open in the other tank circuit. Remeasure and record the resonant frequency as Fo. This is a measurement of the resonant frequency of just one uncoupled tank circuit.

3. Now solve the equation below for the coefficient of coupling, k. The coefficient of coupling is a value between 0 and 100. If two coils are tightly coupled they will have a high k, 100 being perfect. Loosely coupled coils have a low k.

$$k = \sqrt{1 - \frac{Ls}{Lo}}$$

Measure coefficient of coupling of loosely coupled coils.

1. Measure the inductance of one coil and record it as L. This is a measurement of the inductance of one inductor coupled to the other coil.

2. Make a short across the other inductor. Remeasure and record the inductance as Ls. This is a measurement of the resonant frequency of just one uncoupled inductor.

3. Now solve the equation below for the coefficient of coupling, k. The coefficient of coupling is a value between 0 and 100. If two coils are tightly coupled they will have a high k, 100 being perfect. Loosely coupled coils have a low k.

$$k = .5\left(1 - \frac{L}{Ls}\right)$$

Measure mutual inductance for two loosely coupled coils.

3. Now measure the inductance of both coils in series. Record this value as L1.

4. Reverse one coil and measure the inductance of both coils in series. Record this value as L2. You have measured the resonance of the coils in and out of phase.

5. Solve this equations with the values you have recorded.

$$M = .5\ k\ L1\ L2$$

Measure the Q of a coil.

Note: To measure the Q of a circuit you must add a detector circuit, see page 10, and couple it the MFJ-203 (this may slightly alter the Q of the circuit.)

1. Connect a high impedance digital voltmeter across the test circuit in the figure below. Use the lowest range of the voltmeter.
2. Couple the MFJ-203 to the tank circuit. Adjust the Tune control for a maximum voltage reading on the voltmeter. Do not change the coupling during the rest of the test. Record this frequency as F0.
3. Find a point above and below F1 that the voltage is at 70 % of its max. Record these frequencies as F1 and F2.
4. Divide the positive difference between F1 and F2 by F0 to get Q.

Note: Relative Q can be observed by noting the stepness of the dip as you change frequency. A sharp deep dip at resonance is an indication of high Q. A wide shallow dip at resonance is an indication of a low Q.

Using the MFJ-203 as a frequency generator

The MFJ-203 can provide a moderately stable signal source for testing and alignment. The output can be taken from the Coupling Coil jack. This will allow a frequency counter to be used to measure the output frequency of the MFJ-203.

An attenuator pad or variable resistor can be used to reduce the output level of the MFJ-203.

Using a receiver to measure the MFJ-203 frequency.

The FREQ. OUT jack of the MFJ-203 supplies enough signal to drive a frequency counter or a receiver. The signal from this jack is strong enough to drive all but the poorest receivers without direct coupling.

To measure the frequency with a receiver you should first connect a short wire to the input of the receiver or to the center conductor of coax feeding the receiver. This wire can normally just be placed near the MFJ-203 to provide ample signal strength for the receiver. In rare cases a second wire can be inserted into the FREQ OUT jack and placed near the receiver lead.

To determine the operating frequency of the MFJ-203 the receiver should be set to the widest bandwidth SSB position and tuned to the frequency setting of the MFJ-203 dial. The receiver dial can then be tuned up and down until a signal is heard swooping past.

Zero in on the signal until the pitch becomes very low. The receiver will be approximately on the same frequency as the receiver.

If you use the MFJ-203 primarily on one frequency range you can calibrate the knob. Find a frequency and loosen the set screw on the knob. Carefully pull the knob off and reinsert it at the correct setting. Be sure that the receiver and the MFJ-203 are on the same frequency throughout the procedure.

A second method would be to set the frequency of interest on the dial with a grease pen or other temporary marking device.

FULL 12 MONTH WARRANTY

MFJ Enterprises, Inc. warrants to the original owner of this product, if manufactured by MFJ Enterprises, Inc. and purchased from an authorized dealer or directly from MFJ Enterprises, Inc. to be free from defects in material and workmanship for a period of 12 months from date of purchase provided the following terms of this warranty are satisfied.

1. The purchaser must retain the dated proof-of-purchase (bill of sale, canceled check, credit card or money order receipt, etc.) describing the product to establish the validity of the warranty claim and submit the original of machine reproduction or such proof of purchase to MFJ Enterprises, Inc. at the time of warranty service. MFJ Enterprises, Inc. shall have the discretion to deny warranty without dated proof-of-purchase. Any evidence of alteration, erasure, of forgery shall be cause to void any and all warranty terms immediately.

2. MFJ Enterprises, Inc. agrees to repair or replace at MFJ's option without charge to the original owner any defective product provided the product is returned postage prepaid to MFJ Enterprises, Inc. with a personal check, cashiers check, or money order for **$7.00** covering postage and handling.

3. MFJ Enterprises, Inc. will supply replacement charges free of charge for any MFJ product under warranty upon request. A dated proof of purchase and a **$5.00** personal check, cashiers check, or money order must be provided to cover postage and handling.

4. This warranty is **NOT** void for owners who attempt to repair defective units. Technical consultation is available by calling (601) 323-5869.

5. This warranty does not apply to kits sold by or manufactured by MFJ Enterprises, Inc.

6. Wired and tested PC board products are covered by this warranty provided **only the wired and tested PC board product is returned.** Wired and tested PC boards installed in the owner's cabinet or connected to switches, jacks, or cables, etc. sent to MFJ Enterprises, Inc. will be returned at the owner's expense unrepaired.

7. Under no circumstances is MFJ Enterprises, Inc. liable for consequential damages to person or property by the use of any MFJ products.

8. **Out-of-Warranty Service:** MFJ Enterprises, Inc. will repair any out-of-warranty product provided the unit is shipped prepaid. All charges will be shipped COD to the owner.

9. This warranty is given in lieu of any other warranty expressed or implied.

10. MFJ Enterprises, Inc. reserves the right to make changes or improvements in design or manufacture without incurring any obligation to install such changes upon any of the products previously manufactured.

11. All MFJ products to be serviced in-warranty or out-of-warranty should be addressed to **MFJ Enterprises, Inc., 921A Louisville Road, Starkville, Mississippi 39759, USA** and must be accompanied by a letter describing the problem in detail along with a copy of your dated proof-of-purchase.

12. This warranty gives you specific rights, and you may also have other rights which vary from state to state.