RF Field Strength Meter

This meter measures the power density of radio waves from .5 MHz to 3000 MHz (3 GHz). Accuracy in the cell tower range (800 – 1700 MHz) is +/-20% of the reading. At the frequency limits .5 MHz and 3000 MHz, it reads 3 dB low (-50%). There are 3 ranges that span from .001 to 2000 microwatts/cm^2.

The bandwidth switch allows a highpass function (with a 6 dB per octave rolloff below 100 MHz) so that only the high frequencies such as cell towers are allowed through. This switch can also be set to “Wide” bandwidth, allowing all frequencies down to .5MHz, including AM radio. For rapidly fluctuating signals, the “update” switch can be set to “slow” to smooth out the readings. Normally this is set on “Fast” however, so you can see changes rapidly. Controls on the side allow you to neutralize the offset which is temperature dependent and is usually a few nanowatts (.001 microwatts) per cm^3. This meter uses a standard 9-volt battery (included) and has a low battery indicator on the display. Battery life is typically 3 hours of measurement time. Warranty is one year.

For general operation, turn the left knob to 19.999. Then make sure “Bandwidth” is on “Narrow” and “Update” is on “Fast”. If the digital display is changing too rapidly to read it easily, switch “Update” to “Slow”. If you only want to measure high frequencies such as cell towers and microwave ovens, switch “Bandwidth” to “Narrow”. To see all RF frequencies, switch to “Wide”. Make sure your hand is not blocking the top third of the meter. The sensor is in the top of the meter and the meter should be held vertically upward (it measures the vertical electric field component of the RF wave and converts that number to a power density on the display).

Because your body (and other objects) reflect radio waves, there is some ambiguity in the readings. This is especially true at the higher frequencies. You’ll notice that if you first measure and then reduce the distance from your body to the meter by one inch, the reading may change. Also as you move the meter, the reading may repeatedly go higher-lower-higher every inch or so. You should take an average in this case. Generally, the RF waves have most of their power in the vertical electric field, but some is in the horizontal. To get a true measurement of the total RF power density propagating toward you hold the meter vertical (with the battery-lid-side facing the object you’re testing) and read that number. Then turn the meter horizontal (either 90° left or right of vertical, with the back still facing the object you're testing) and add that number to the vertical reading. This gives the sum of vertical and horizontal power density.

If the meter is in very high or very low ambient temperature, the display may add or subtract a small offset (equivalent to a "tare weight") of a few times .001 microwatt/cm² to the displayed measurement. You can check to see if there is an offset by moving the meter to an area with low RF (less than 0.200). If you are in a low-RF area (less than 0.010), cover the top of the meter and most of the back with your hands to minimize the RF that reaches the meter. Otherwise, at higher RF levels, cover the meter entirely with metal foil (aluminum) except for the display. Turn settings to 19.999, "Narrow" and "Fast". If the display does not read 0.000 or 0.001: Remove the battery door. Inside there is a pushbutton switch and next to it a dial. While pressing the button, turn the exposed control dial with a Phillips screwdriver until the display reads zero. (There is no need to remove the battery from its position for this operation).

Internal controls:

In some cases, such as an extreme temperature, there may by an offset on the displayed value of microwatts per cm^2. That is, if the meter is in zero field, it may accidentally read, for example, "0.013" on the 19.999 range and therefore "00.01" on the 199.99 range. You can check if an offset (as in this example) is present and correct it by sliding off the battery back. You will see a small black pushbutton near the battery. If you push and hold it down, the RF amplifier will be turned off. (This is equivalent to operating the meter in zero field.) If the display is not reading zero after this button is held down for at least 30 seconds, there is a square potentiometer that can correct the offset. It is next to the button and has a Phillips head. (Do not try to change the other potentiometer, which is sealed with glue. That is the RF gain control.) With the range knob on 19.999 and the button held down, adjust this potentiometer until the display reads zero. Please note that you should hold the button at least 30 seconds until the displayed number is stable. Also, negative numbers are possible. Once zeroed, it will also read zero on the 199.99 and 1999.9 ranges.

If LOW BATTERY shows on the display, you have about 15 minutes of battery life left. Slide the back lid off (in a direction away from the 2 screws) and replace the 9 volt battery.

For comparison, maximum allowable exposure for any public area is 600 microwatts/cm^2 for an analog cell tower (at about 890 MHz). Typical city background (over a mile from any major transmitter) is around 0.100 microwatts/cm^2. Typical background in the country is about 0.010 microwatts/cm^2.

[*The rest of these instructions goes into more detail about using the meter to estimate the average frequency of an RF signal, and also the directionality of RF measurements.*] When measuring an RF signal of unknown frequency, you may notice that the reading is different when the Bandwidth switch is set to "Wide" vs. "Narrow". If so, you can estimate the average frequency (averaged over the power density) of the RF spectrum. If it's just a wave of a single frequency, you can estimate the frequency of that wave.

This estimate is done by measuring the power density with the Bandwidth switch set at "Wide", and then measuring the power density with the switch set to "Narrow". If these numbers are the same, the average frequency is above 1 GHz. If the "Narrow" number is less than 1% of the "Wide" number, then the average frequency is below 10 MHz. If the "Narrow" number is between about 1% and 99% of the "Wide" number, you can estimate average frequency from the ratio of the two numbers.

To calculate the average frequency, take the ratio of the "Wide" reading to the "Narrow" reading. This number will be 1.00 or greater.

If this ratio is:	Then the average frequency is:
1.01	1 GHz
1.05	450 MHz
1.1	315 MHz
1.2	220 MHz
1.5	141 MHz
2	100 MHz
3	71 MHz
5	50 MHz
10	33 MHz
20	23 MHz
50	14 MHz
100	10 MHz

The formula is:

F = 100 MHz / R-1

Although most commercial RF transmitters radiate with a vertical antenna and thus a vertical electric field (so you can hold the meter vertically to measure the full power density), some RF radiation also has some horizontal component, due to reflections or transmitters that have antennas not pointed vertical. If you know where the transmitter is, you will only have to perform two readings to find the transmitter's total power density at your position. These correspond to "Z" (vertical) and "X" (horizontal, but perpendicular to the direction of the transmitter). In theory, if you point the meter's long axis toward the antenna (the "Y" direction), you will not detect any radiation from that antenna. This seems counterintuitive. (In fact, there may be some diagonal reflectors near you that produce a small "Y" component coming from the transmitter, but this is not usually significant).

In practice, if the back face of the meter is facing the RF source, and the meter is read first in the vertical orientation and then it is read after being rotated 90° to the horizontal position (with the back face still facing the RF source), the sum of those two numbers will be the true power density from that transmitter. (This addition is a "sum of squares". That is, because power density is proportional to the square of the electric field, then the direct sum of these two numbers, and not the square root of the direct sum, will be the correct magnitude of the power density.) Most RF field sources are principally vertically polarized, in which case only the vertical reading needs to be done. To measure the full power density at a certain point in space, regardless of the sources' locations, measure the vertical first (meter pointed upward). This will usually be the majority of the RF power density. Then make two measurements 90° apart, with the meter's long axis pointed in the horizontal direction. For example, after the vertical measurement, measure holding the meter in a north-south orientation and then in an east-west orientation. The sum of these three numbers is the total power density at that point in space, regardless of the position of the transmitter or transmitters. An accuracy problem arises however, because your body can block RF radiation, so if an unseen transmitter is located on the opposite side of your body from the meter, the reading will be falsely low. If you hold the meter higher than your head, this problem disappears. The presence of your hand and arm will have some effect on the field strength at the meter, so the most accurate reading is taken by setting the meter on a non-metallic surface or using, for example, a plastic holder.