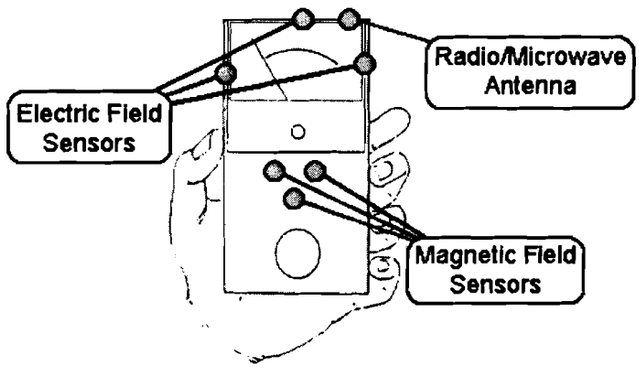
TriField® Meter Instructions

TAKING READINGS

Hold the meter as shown. Do not cover the top of the meter. This prevents your hand from shielding electric fields or microwaves. (Your hand cannot shield magnetic fields.) Read the *top* scale when the knob is set *on* "MAGNETIC (0-100 range)". This top scale reads in milligauss. For more sensitivity to weak magnetic fields, set knob on "MAGNETIC (0-3 range)", and read the *center* black scale. When the knob is set on "ELECTRIC", read the *top* scale, and multiply by 10 to get volts/meter. Point the top of the meter toward the electric field source being measured. When the knob is turned to "RADIO/MICROWAVE, use the bottom scale (.01-1 milliwatt per square centimeter) and point the meter toward the radio/microwave source.



Avoid long term personal exposure to HIGH (red scale) readings in any setting; they pose a possible (but not yet certain) health risk. The dotted red scale is borderline exposure, and probably poses little if any health risk. Below that is generally regarded as safe for continuous exposure.

BATTERY TEST

Switch the knob to "Battery Test". If the battery needs replacement, the needle will be to the left of the line that is itself left of the words "Batt. Test".

CALIBRATION

Normally, the indoor RADIO/MICROWAVE reading should be near zero in most parts of homes or offices, and will almost certainly be zero if you cup your hand in front of the meter or place the meter in a metal box. In rural areas, far from power lines, the magnetic field should also read very low (below .2 milligauss).

High Magnetic Field Sources

Hold the meter near these sources, and set the knob on "MAGNETIC (0-100 range)". Some of these should read greater than 10 milligauss on the top scale. Your body or hand does not shield these.

- AC wall adaptors
- Vacuum cleaner or motorized equipment
- TV screens
- Plug in clock/radio
- Lightning
- Inside of commercial jets
- Running cars, especially near front floorboard

If you can't get a reading greater than 10, test the battery. (If the battery is weak, the meter needle cannot go up to full scale.)

High Electric Field Sources

Switch the knob to ELECTRIC. If you point the top surface of the meter box (the surface furthest from your hand) toward these sources, some should read greater than 3 kilovolts per meter. (Notice that your body can easily shield electric fields; the reading is lower if you cover the top surface of the meter with your hand. Also, the presence of your hand at the back of the meter *compresses the* electric field, making it read somewhat higher than if the meter were suspended from a string far away from you.

- Most type of TV/computer monitors
- Improperly grounded electrical equipment
- Single "hot" wire, even if insulated
- Fluorescent lights
- Electric Blankets, when plugged in, but "off', especially if the AC plug polarity is reversed

High Radio/Microwave Power Sources

Switch to RADIO/MICROWAVE and point the radio/microwave sensor toward the following sources. Read the bottom scale. Your hand can shield the higher frequencies (microwave) but not lower frequencies. Strong sources include:

- Cordless phones, CB, or amateur radio transmitter*
- Microwave ovens near door seal. A reading of more than .2 m W / cm^2 (needle halfway up) at a distance of six feet suggests a leaking microwave door seal, which should be repaired.

**Will also produce electric and magnetic field readings.*

CHANGING THE BATTERY

The battery is a 9-volt rectangular type. The alkaline type will last about 30 hours of continuous use, while the transistor type will last about 10 hours. Turn the meter OFF, unscrew the back (four screws) and slowly separate the back cover. DO NOT PULL APART RAPIDLY - it may break the wires. Disconnect the battery and slide it out by pushing it out from the back. Then replace it. Reconnect the new battery and reassemble. Leave the meter OFF when not in use; even "Battery Test" will draw some power.

SPECIFICATIONS

TriField 60 Hz / 50 Hz Versions: The MAGNETIC and ELECTRIC field settings are frequency-weighted from 30 to 500 Hz and are calibrated at 60 Hz (50Hz). For example, a 60 Hz (50 Hz) magnetic field with a strength of 2 milligauss will read "2" on the meter, but 120 Hz (100 Hz) at 2 milligauss will read "4" on the meter. This is to gauge the currents induced inside the body, which are proportional to field strength multiplied by frequency. From 500 Hz to 1000 Hz, the response is flat + / -20%. Above 1000 Hz, the magnetic and electric sensitivities of the meter slowly decrease with increasing frequency, falling to zero near 100 KHz, but with some residual sensitivity up to 100 MHz. In theory, the body's sensitivity to fields should begin to decrease at frequencies above about 500 Hz. Accuracy is + / -20% of scale reading for MAGNETIC, and + / -30% for ELECTRIC (RMS @ 60 Hz / 50 Hz).

Flat Version: The frequency response of the meter at MAGNETIC or ELECTRIC field setting is flat +/-20%, from 30 to 1000 Hz. Above 1000 Hz, the magnetic and electric sensitivities of the meter slowly decrease with increasing frequency, falling to zero near 100KHz, but with some residual sensitivity up to 100 MHz. (In theory, the sensitivity of the human body to fields should begin to decrease at frequencies above about 500 Hz.) Accuracy is + / -20% of scale reading for MAGNETIC, and + / -30% for ELECTRIC.

All Versions: RADIO/MICROWAVE is sensitive from 50 MHz to 3 GHz and is calibrated at home microwave oven frequency (2 GHz). The accuracy is -50% to +100% because of the unpredictable effect of reflections within the room and off the user.

WARRANTY

The unit is warranted against defects in materials and assembly for one year from the date of purchase. Customer should return defective unit, shipping prepaid, for repair or replacement.

DISCLAIMER

Use of the meter is solely at the user's discretion to identify personal exposure to nonionizing electromagnetism of the strength and types believed (as of November 1996) to pose a possible health risk. Because a meter of this type may malfunction, the user's responsibility is to determine if the meter is working properly by using it to measure a known reference (see CALIBRATION section of this booklet). Manufacturer or dealer cannot assume responsibility for damages resulting either from a defective meter (except to replace or repair said meter within the warranty period) or from inaccuracies in the present body of knowledge concerning the health hazards of electromagnetism.

The meter should be used so that simple steps (such as moving furniture) can be taken to reduce relative exposure within a home or office. If more drastic actions are contemplated, remember that *some readings in the HIGH (red) zone may ultimately prove not to pose a health risk,* so consult expert advice, *and perform independent tests with another type of meter.* Remember that the TriField® meter is frequency-weighted (except Flat Version), so in most environments, it will read higher in the magnetic field setting than a more traditional meter of the type used in epidemiological studies to set possible hazard thresholds.

The TriField® Meter

Although not yet proven, direct and indirect evidence suggests that AC electric and magnetic fields increase the risk of certain cancers (such as leukemia and primary brain tumors) and other physiological and psychological abnormalities (some people report a difficulty in concentrating when exposed to high fields, and some studies suggest that fields suppress the production of sleep inducing melatonin). Although how this happens is not fully understood, both magnetic and electric AC fields that surround the body can produce AC electric current inside the body. The best available theory is that this current interferes with the normal transport of ions across cell membranes. (1)

At a continuous exposure of about one billionth of an amp of AC current per square centimeter (give or take a factor of three), biological effects begin to be observed. Very preliminary results show that at five times that level, for example, an increase in protein production in cancer cells is seen; but when the field is increased 1000 times further, the increase in protein production is only three times greater (not 1000 times greater). These changes are seen for AC current at several different frequencies, including 60 Hz (60 oscillations per second). (2)

If the cell-membrane-interference theory is correct, the body should be sensitive to current at any frequency up to about 1000/Hz; above that sensitivity will decrease (the exact frequency is not known and experimental measurement of it has not been attempted). The currents induced by artificial fields may also affect the nervous system directly, and the evidence of this is somewhat stronger than that of the cancer effect. Exposure to a fairly strong magnetic field of 300 milligauss (at 60 Hz) will consistently slow down subjects' heart rate by about 3 beats per minute for 3 or 4 minutes after the field is turned on, even though subjects cannot directly sense the field. (3) This field strength is the strongest typically encountered in the home, but weaker fields may produce more subtle effects that take longer to manifest themselves.

Based on the above evidence and some epidemiological studies (4), it would be prudent to avoid continuous exposure to any electromagnetic pollution that produces AC current inside the body higher than one billionth amp per square centimeter, at frequencies of 1000 Hz or below. (No absolute hazard threshold has been established yet, but the lower limit for biological effects is probably give or take a factor of three from that level). Preliminary results suggest also that it's better to spend a short time well above this threshold than a long time just above it.) At frequencies above 1000 Hz, the body is likely also to be sensitive, but not as sensitive as it is to lower-frequency current.

An external magnetic field of 3 milligauss or an electric field of 2.5 kilovolts/meter at 60 Hz will produce approximately one billionth amp per square centimeter. The current produced inside the body is proportional to field strength times frequency, so at 120 Hz (twice the frequency), only half as much field (i.e., 1.5 milligauss and 1.25 kilovolts/meter respectively) is required to produce the same current inside the body. Interestingly, a fairly strong magnetic field (500 milligauss) and electric field (about 2 kilovolts/meter) exist in nature, but these fields are **static**; and thus have a frequency of zero--they produce no current inside the body.

Any measurements of electromagnetic pollution should probably be frequency weighted, meaning that they read the product of magnetic field strength times frequency and/or electric field strength times frequency, if the measurements are to gauge whether the current inside the body exceeds a threshold level. This frequency-weighting should extend up to about 1000 Hz and then sensitivity should decrease at higher frequencies. Previous measurements that looked for a link between cancer and field strength have used several types of metering: some frequency-weighted,

some not, and some measuring only 60Hz fields (or 50 Hz outside North America). Different types of meters read differently, thus making it more difficult to establish whether a link exists.

Magnetic and electric fields are vector quantities. This means they are specified as having a magnitude (or field strength, measured in milligauss or kilovolts/meter respectively) as well as a direction (an "arrow" showing which way they are pointing). The effect on the body is more or less independent of the direction of the field; only the **magnitude** is important. Many of the measurements of possible cancer-field links were of the field strength in one direction only. The sensor in these measurements had to be pointed in the same direction as the field was pointing; otherwise, the reading would be less than the true magnitude of the field strength. (If the sensor were erroneously pointed perpendicular to the local field direction, the reading would be "zero", no matter how strong the field actually was.) To avoid this inaccuracy, all studies should be done with meters that read the true magnitude of the field, so a researcher could walk through a room with a meter and get an accurate, immediate reading of the field magnitude at every point along the path, regardless of which way the meter is oriented.

One more matter that complicates the interpretation of the strength of fields has to do with how magnetic fields induce current in the body. The current per area induced is proportional to field strength times frequency **times the length of the body**. For this reason, children exposed to magnetic fields experience **less** current per area than do adults, and lab rats experience about 1/10 as much. The multiplication by body length does not apply to **electric** fields, however (so a rat would experience the same current as a human, when exposed to an electric field).

The TriField meter combines all the features needed for fast, accurate measurements of electromagnetic pollution. It independently measures electric field and magnetic field **and is properly scaled for both, to indicate the full magnitude of currents produced by each type of field inside the human body**. As a result, it "sees" much more than any other electromagnetic pollution meter. Depending on where the knob is set, it detects either frequency-weighted magnetic fields (two separate scales) or frequency-weighted electric fields in the ELF and VLF range (it has significant sensitivity at 100,000 Hz, well past the 17,000 Hz horizontal scan of video displays). It also has a setting which lets you gauge radio wave power all the way up to three billion Hz (3 GHz), CB and cellular phone equipment, and many radars.

This meter is the only one which combines magnetic, electric, and radio/microwave detectors in one package, so the entire nonionizing (that is, not including nuclear radiation) electromagnetic pollution spectrum is covered. In addition, the magnetic setting and the electric setting measure **true magnitude**, a feature found elsewhere only in more expensive meters. If you hold the meter in the center of a room and tip it to various angles, the magnetic reading will stay approximately the same (+/- 15% typical) regardless of which way you tip or rotate it. The electric reading is similar, although the presence of your body alters the actual electric field, so readings will vary more. The radio/microwave setting reads full power of radio waves radiated into the front of the meter.

The TriField meter is one of the least expensive available. The few other meters in this price range $150 read **only** low-frequency magnetic fields and **only** one direction. The magnetic section of the TriField meter has three field-detecting coils pointing in the X, Y, and Z directions. A circuit amplifies these signals and gives them the proper frequency-weighting (sensitivity increases linearly from 30 Hz to 500 Hz, but with some residual sensitivity up to 100 MHz). A unique network combines the three coil outputs nonlinearly to approximate a true magnitude. The meter is sensitive from .2 to 100 milligauss full scale at 60 Hz* (or .1 to 50 milligauss full scale at 120 Hz, etc.) with a resolution of .2 milligauss in the sensitive range. Accuracy is +/-20% at mid-range.

In most homes and offices, a large fraction of the total magnetic field is at frequencies above 60 (or 50) Hz. A TriField meter, when exposed to a 3 milligauss field, will read "3" if the frequency of the field is 60 Hz, but it will read "6" if the 3 milligauss field is at 120 Hz. In contrast, a nonfrequency-weighted meter will read "3" in both cases, and a 60 Hz-only meter will read "3" and "0" respectively (even though in the 120 Hz case, the current induced in the body is **twice** as much.) This underscores a problem with present epidemiological studies of magnetic field health effects: generally, non-frequency-weighted meters (or even 60 Hz-only meters) were used. Several studies suggest that in homes where these meters read consistently above 3 milligauss the chance of developing certain cancers is increased (5). Depending on the distribution of frequencies (which was **not** recorded in the studies), a TriField meter would generally read between "3" and "9" if the other meters read "3". Consequently, the threshold for the TriField might be more appropriately placed as high as "9" milligauss, with the uncertainty arising because previous studies did not measure frequencies above 60 Hz in a standard or uniform way.

The electric section consists of three metal plates under the meter face. Because the meter housing is plastic, the electric fields can penetrate through to the plates, which are also arranged to detect AC electric fields in the X, Y, and Z directions. Circuitry similar to the magnetic section converts the signals into an electric field signal which is frequency-weighted. Sensitivity is 0.5-100 kilovolts per meter (KV/m) at 60 Hz*, with resolution of 0.5 KV/m (1 KV/m =1000 V/m). Accuracy at mid-range is +/-30%.

Radio and microwaves are composed of a particular combination of electric fields and magnetic fields that is self-sustaining. For frequencies below about 100 MHz (100 million Hz) the principle effect on the human body is from the magnetic field part only. This is because the electric field component of radio waves produces much weaker currents in the body than does the magnetic field unless the wavelength of the waves is smaller than the height of the body. Low-frequency electric fields **by themselves** can be strong enough to create significant current, but only if they are from sources other than true radio waves.

The radio/microwave section has a small L-shaped antenna in the front. The signal is amplified and converted to a power density magnitude, calibrated at typical home microwave oven frequency (2 GHz). It reads 0 to 1 milliWatt/square centimeter. The resolution in the low range is 0.01 mW/cm^2, which is the Russian standard for maximum safe microwave exposure to avoid changes in brain activity(6), and is the most conservative standard of any country. In contrast the US legal maximum is **1000** times higher, at 10 mW/cm^2, but only brief exposure is allowed at this level. As mentioned, a true radio wave is a particular combination of electric and magnetic fields. A radio wave strength of 0.01 mW/cm^2 has 0.006 KV/m and 0.2 milligauss, respectively, of electric and magnetic field (RMS averaged), while a strength of 1 mW/cm^2 corresponds to 0.06 KV/m and 2 milligauss. Typical accuracy is within a factor of two. Variations are caused by reflections off the user's hand and body.

A knob on the front has six positions: OFF, BATTERY TEST, two MAGNETIC field sensitivities (0.5-100 milligauss at 60 Hz", and 0.2-3 milligauss at 60 Hz., the Second sensitivity to measure weak fields more accurately), ELECTRIC field and RADIO/MICROWAVE power density. The meter face is analog (needle type). A needle reading of one-third of full scale corresponds to either 3 milligauss (or 0.6 milligauss) @ 60 Hz*, 3 kilovolts/meter @ 60 Hz", or 0.04 mW/cm^2 respectively in the magnetic, electric, and radio/microwave field settings. Long-term personal exposure to levels higher than these should probably be avoided, so the meter is labeled "HIGH" above these levels. Unfortunately, because of uncertainty of population studies, any true health - effect threshold may be as low as 1 milligauss or as high as 10 milligauss.

In most homes or offices, some areas are "hot" spots with readings in the HIGH range. Most often, this is caused by magnetic fields, which come largely from unpaired internal wiring. (Contrary to popular belief, power transmission lines and transformers do not generally contribute as much magnetic field as does internal wiring.) Other magnetic sources include video displays, motorized clocks and other equipment, electric blankets and heaters, fluorescent lights and light dimmers, and the transformers that are inside consumer devices. Many of the effects are from frequencies that are **harmonics** or **multiples** of 60 Hz (120 Hz, 180 Hz, etc.) and 17,000 Hz of video displays. Cars (especially near the front floorboard of electronic ignition cars) and motorcycles have fairly strong fields that are at frequencies higher than 60 Hz. Magnetic field is difficult to shield, but sheet steel is somewhat effective.

A few areas in most homes read HIGH in the electric field setting. These include areas near improperly grounded equipment, the front of video screens, and .fluorescent lights. Most of these fields can be easily shielded using a grounded metal screen or foil; VDT screens of this type are readily available. You can greatly reduce the strength of an electric field just by placing your hand in front of the source. This effect can be seen using a TriField meter.

Occasionally, certain areas read HIGH in the radio/microwave setting. These include door seals around microwave ovens, and cellular phones (but **not** regular radio phones, which are very low-power). Radio/microwaves can be shielded in the same way as electric fields, although the lower frequency radio waves are not shielded by your hand as easily as microwaves are. (Metal screens will shield both.) In the U.S., radars and FM transmitters can legally expose residents to moderately high power levels (as high as 10 mW/cm^2 briefly), but such exposure is not common.

By seeing "hot" spots in your home and office, you can move furniture, cribs, or beds to reduce exposure. You can also take corrective action to avoid long term exposure to appliances that emit high electromagnetic pollution levels. If you have unusual sensitivity to a particular type of field, you can identify where problems exist (e.g., wearers of pacemakers should avoid even brief exposure to high radio/microwave power levels. Some evidence suggests that brief exposure to very high AC electric or magnetic fields may cause nervousness or seizures in some people.)

The TriField meter comes with a one-year warranty and a 9-volt transistor battery included. This type of battery lasts about 10 hours (total measurement time). When the BATTERY TEST reads low, the battery can be replaced with any rectangular 9 volt transistor or alkaline (which lasts about 50 hours) type. This meter is manufactured in the USA. TriField is a registered trademark of W.B. Lee.

(1) EPA Draft report March 1990. See Nature, vol. 345, 6-7-90, pg. 463.
(2) Science News, vol. 137, no. 15, pg. 229, April 14, 1990. This assumes average body resistivity of 150 ohm-em.
(3) Science, vol. 249, pg. 1379, September 21, 1990.
(4) Several studies are in the literature. For example, The Lancet, January 29, 1983 pg. 246; New England Journal of Medicine, vol. 307, noA, July 22, 1982, pg. 249 "
(5) See The EMF Book by Mark Pinsky for a summary of studies.
In a study of about 500,000 people, continuous exposure to 2 mG (at 50 Hz in Europe) correlated to a 2.7-fold increase in childhood leukemia rate. See New Scientist, 31 Oct 92, p. 4.
(6) See The New Yorker, June 12, 1989, pg. 69; and Cancer Research, August, 1988, pg. 4222.

*The 50 Hz version (see back label of meter) is calibrated at 50 Hz.