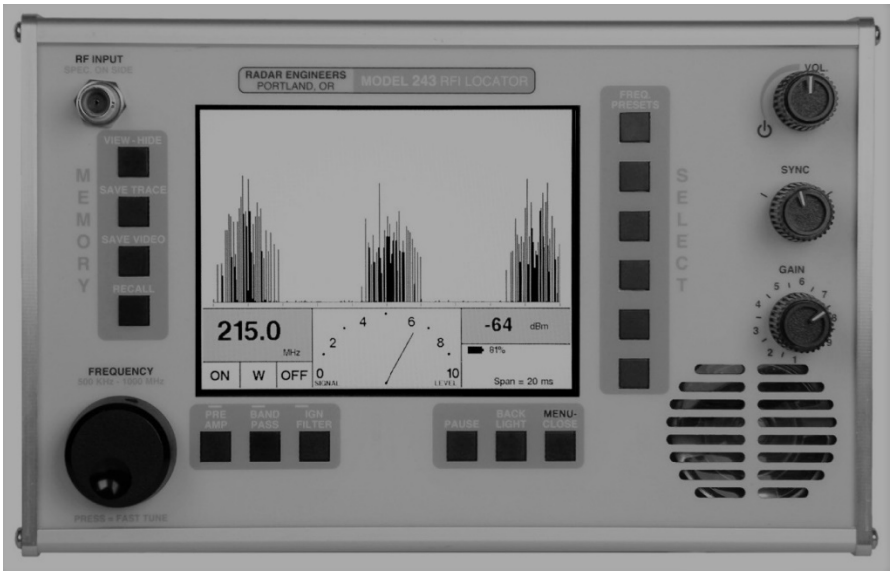
MANUAL



MODEL 243

RFI LOCATOR

RADAR ENGINEERS INC
9535 NE COLFAX STREET
PORTLAND, OR 97220

RECOMMENDATIONS FOR BEST 243 BATTERY PERFORMANCE

1. The 243 uses nickel–metal hydride (NIMH) batteries. To achieve the best performance and longevity from them, please observe the following recommendations:

- **Do not store in a low state of charge (below 50%).**
- **Recharge every 2 months.**
- **If stored for over 1 month, charge before use.**
- **See manual for additional battery information.**

2. To maintain best battery charge indication do not leave the 243 plugged into vehicle 12 volts when engine is <u>not</u> running. Use the 243 15V wall charger for regular charging of the 243.

10/4/2022

Contents

I. SAFETY NOTE 

The Model 243 RFI Locator and Antenna should be used from the ground level only. THIS INSTRUMENT AND ANTENNAS ARE NOT INSULATED. SAFE WORKING DISTANCES MUST BE MAINTAINED FROM ELECTRICAL CONDUCTORS. DO NOT USE INSIDE SUBSTATIONS OR SWITCH YARDS, UNLESS UTILITY RULES PERMIT.

THIS INSTRUMENT IS NOT A VOLTAGE SENSOR. The presence of high voltage will cause little if any, response from the portable RFI locator.

Ensure that at least four feet separate any vehicle transmitting antenna and roof mounted RFI locating antenna. The antennas should never be allowed to touch each other, even if bent over. In the event that the vehicle operator keyed the VHF/UHV microphone and the antennas were too close, unsafe levels of RF power could be transmitted to the RFI locating antenna and then to the RFI receiver.

Do not inject more than 5 V RMS into the RF antenna BNC input.

If using the Model 243 in a vehicle, secure the receiver against movement and observe safe driving practices.

EXERCISE CAUTION AT ALL TIMES.

II. GENERAL INFORMATION

INTRODUCTION: The Model 243 RFI Locator was designed to help utility crews efficiently locate the sources of powerline sparks that cause radio, TV, CATV, DSL, LTE and powerline carrier interference. It can be used to locate sources of electronic interference, such as light dimmer controllers or switching power supplies. And it can be used for powerline preventative maintenance surveys.

The Model 243 consists of a tuner covering the frequency range of 500 KHz – 1000 MHz. It has a built in waveform display. The circuitry in the receiver mode has been maximized to detect sparking rather than radio or TV reception. The waveform display is optimized for viewing powerline RFI.

SPECIFICATIONS:

Frequency Range:
Receiver: 0.500 MHz – 1000 MHz
Spectrum: 0.500 MHz – 1000 MHz

Operating Voltage & Current: 12 - 16 VDC 2A
Charging Voltage: 12 – 16 VDC 2A Max.
Operating Temperature: -10° - 50°C (14° - 122° F)
Charging Temperature: 0° - 40°C (32° - 104°F)
Operating Altitude: Up to 2000m (6600 Feet)
Maximum Relative Humidity: Maximum 80% for temperatures up to 31°C (88°F) decreasing linearly to 50% relative humidity at 40°C (104°F)

-Triangle indicates caution, read manual with care.

Cleaning: Clean the Model 243 with a soft cloth dampened with water or water with a mild cleaning solution. Do Not use solvents or abrasive cleaners.

Protection Impairment: If the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

Check Up: It is recommended that the instrument be returned to the factory every three years for calibration, battery check and general tune up.

III. FEATURES OF THE MODEL 243

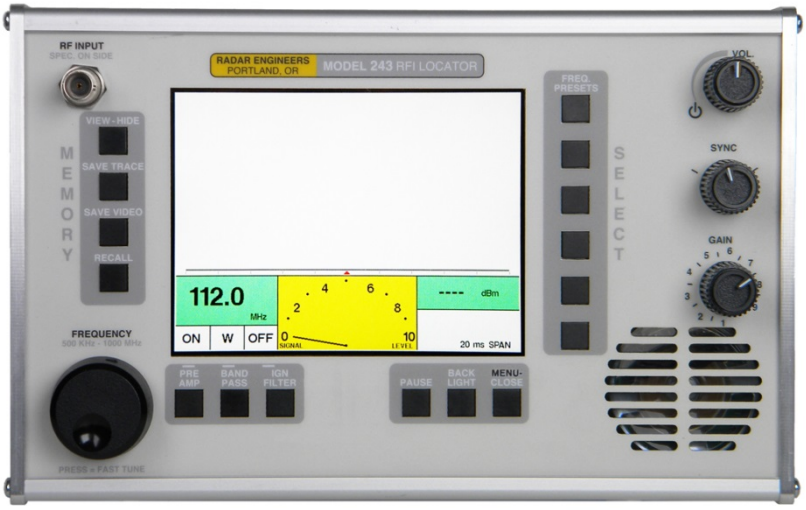


Figure 1. – Model 243 Front Panel

RF INPUT: 50 Ohm BNC connector for the antenna input.

LIQUID CRYSTAL DISPLAY: The LCD display is designed to be usable and visible in all lighting conditions. (Even so, do not leave the LCD display exposed to direct sunlight for extended periods of time.) The LCD is used to display the frequency and waveforms detected by the unit. Also displayed is a signal level meter, dB levels, and battery charge status. In receiver mode the display is fixed to show a 20 msec span. This is about one and a quarter cycles in a 60Hz power system.

ON/VOLUME (VOL): Switch turns instrument on/off and sets volume level. After 60 minutes of continuous use the receiver automatically turns off unless the "AUTO OFF" feature has been disabled in the "Settings" menu. To restart the unit after it turns off automatically, turn the volume knob off for 5 seconds, then turn it back on.

SYNC: Use this knob to help control the drift of 60Hz spikes across the display. (Non-60Hz noise such as ignition noise cannot be controlled with the sync knob.) Normal position for the sync control is 12:00.

GAIN KNOB: This control sets the desired amount of sensitivity.

FREQUENCY KNOB: This knob is located on the lower left hand corner of the panel and is used to select the desired frequency. Below 50 MHz the frequency is tunable in 5 KHz steps. Above 50 MHz the frequency is tunable in 0.1 MHz steps. Pushing the knob in and then turning it permits tuning in larger steps. Frequency is shown continuously on the LCD.

PREAMPLIFIER SWITCH (PRE AMP): Selector switch for preamp. Normal operating position is "ON" – meaning the preamp is on or in the circuit. The "OFF" position may be useful

in the presence of extremely strong RFI sources. It can also be turned off when in close proximity to a radio or TV transmitter which could cause intermodulation in the receiver.

BAND PASS: This pushbutton permits selection of a wide (W) or narrow (N) filter. Normal driving position is (W). Filter band passes are wider above 50 MHz. If looking for electronic sources, try the narrow (N) filter where possible. AM radio stations and HAM radio signals should be tuned in using the narrow band filter also. See section VI. A and B below.

IGN FILTER: This pushbutton is located near the bottom of the front panel; the "ON" position enables a digital filter designed to minimize non-60Hz RFI such as ignition noise. It is not a complete mask, but should reduce the distraction caused by vehicle ignition. It does not filter out the video component, which can always be seen on the display. Use only when needed.

PAUSE: Pushing this button freezes the LCD display. Pushing the PAUSE button a second time returns the display to normal operation. When the unit is paused, the word "PAUSED" appears in the lower right corner of the display.

BACK LIGHT: Pushing this button allows the operator to change the display brightness. There are four levels of brightness available.

MENU/CLOSE: This button opens and closes the menu system.

FREQUENCY PRESETS: There are 6 buttons in the "SELECT" column. These are multi purpose frequency preset, and menu option access buttons. Default is "Frequency Preset". To store a frequency preset, tune to any desired frequency, then hold the button in until the unit beeps. The preset menu will appear, showing the preset settings. Push the MENU-CLOSE button to close the preset menu. The Preset Menu can also be accessed from the Main Menu shown in Figure 3.

VIEW/HIDE: Pressing this button will display at the top of the LCD the last stored or recalled waveform trace. Pressing the button again will remove the trace from the display.

SAVE TRACE: Pressing this button will store whatever waveform is being displayed by the Model 243 (time or frequency domain) to a file that can be sent to a non-volatile memory slot. After the waveform is stored, a menu will appear showing all trace memory files in the 243 unit. Selecting a file will store the file just recorded in that file. If another trace was already stored in that file, it will be replaced with the new file. A total of 5 memory slots are available. To delete all 5 traces or videos at once press Delete twice.

Before saving a trace, it can be useful to first "pause" the trace. That will show the waveform that would be saved if the store button is pressed. The "Pause" button can be pressed/released until the desired waveform is seen. "Save Trace" will then store the paused waveform.

SAVE VIDEO: In Receiver mode only, pressing the "SAVE VIDEO" button will save a 10 second video and audio recording of the RFI source that is exactly like the original signal. After the video has been acquired, a message will appear on the display saying "Video Acquired" and the video file menu will appear. Selecting one of the five files will store the video in that file. If a

video had previously been stored in the selected file, that video will be overwritten. A total of five video files can be stored in this manner. The month, day, time and frequency will show for the file. (The live trace will pause midway during the saving of a video file.)

RECALL: Pressing the "RECALL" button will bring up a menu with the selections "RECALL TRACES" AND "RECALL VIDEOS"

Selecting "RECALL TRACES" will bring up the saved traces menu. Selecting one of the saved traces will display that trace in the top of the display window

Selecting "RECALL VIDEOS" will bring up the saved videos menu. Selecting one of the saved videos will play that video, which will last for 10 seconds. During playback, if the RECALL button is pushed again, the video will repeat and play again. This can be repeated as long as the video is still playing.

Figure 2. – End Panel

UPLOADER APPLICATION: The guide for use of the saved Memory Uploader Application is included on the USB flash drive provided with the Model 243. The guide is also found as an insert located at the back of the Model 243 manual.

AC/DC TRANSFORMER: To charge the battery, plug the factory supplied charging module into the 12-16 VDC input on the side panel. The standard charging module is designed for an input of 100 – 240VAC and 50 - 60 Hz. The transformer module output is 15 VDC, 1.0 Amperes.

DC ADAPTER: The Model 243 may be powered and charged from a 12 Volt car battery. First, plug the factory provided cigarette lighter plug adapter into the 12 VDC input on the side panel, then plug into the car receptacle. The D.C. Adapter has an internal 2.5A fuse.

USB (MINI-B): Stored data may be transferred to a computer via a USB cable using this port.

SD CARD: This input accepts an SD card for programming the Model 243.

USB (A): Stored data may be transferred by a USB memory stick to a laptop.

RF INPUT SPEC: Do not exceed 5V RMS 50 OHMS when connected to the RF BNC Antenna input. Switchable power out of 5VDC 10mA max may be present on the BNC to power the AM Probe.

VIDEO JACK: To observe 60Hz pulse groups on an external oscilloscope, plug into the Video jack. Use a one-eighth inch stereo plug. (Audio is on tip and Video is on ring.)

AUDIO JACK: To listen to RFI through headphones or to attach an external speaker plug into the audio jack.

ANTENNAS: The standard antennas provided with the instrument are an amplified loop stick, magnet mount whip antenna and a handheld log periodic antenna.

1. Magnetic Mount Whip

   The magnetic mount whip antenna is most sensitive between about 50 – 80 MHz. However, it can be used from 1 MHz to 500 MHz. It is less sensitive at the frequency extremes and it has peaks and nulls. It is a proximity antenna rather than a directional antenna.

2. Amplified Loop Stick (A.M. Probe)

   The amplified loop stick is sensitive and directional between 500 KHz and 3.5 MHz. Power for the probe is supplied from the BNC Antenna input on the Model 243.

3. Handheld Log Periodic Antenna

   The handheld log periodic antenna is directional between 270 MHz and 1000 MHz. Please note: Directional information is not reliable below 270 MHz. Directionality generally improves as the tuned frequency increases above 270 MHz. A log periodic antenna has a wide beam width (approximately 60 degrees.) On the other hand, it has a very good front to back ratio.

Additional antennas are available. Contact the factory for information

NOTE: NONE OF THE ANTENNAS OR PROBES SUPPLIED WITH THE MODEL 243 ARE INSULATED. MAINTAIN SAFE WORKING DISTANCES AT ALL TIMES.

RECEIVER MODE: The unit defaults to Receiver mode when it is turned on. Pressing the "MENU-CLOSE" button brings up the menu shown in Figure 2 shown below. The menu provides two options, "RECEIVER" or "SPECTRUM DISPLAY".

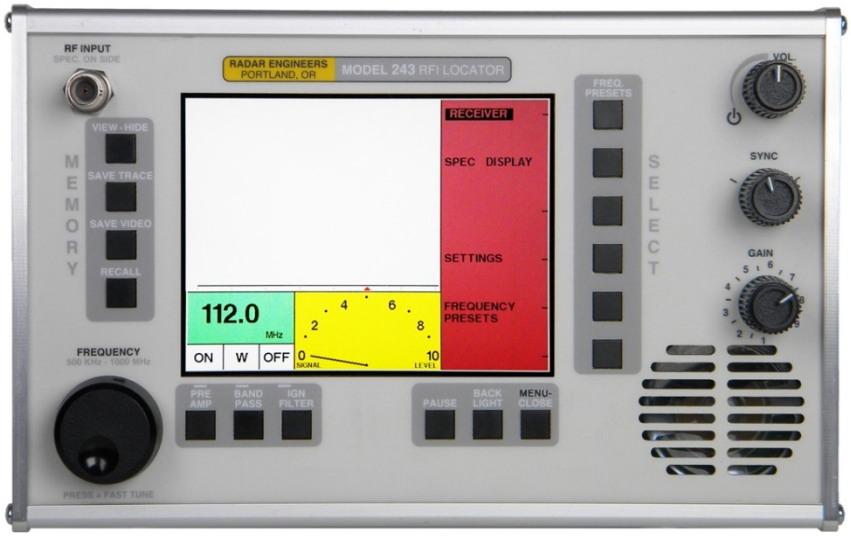


Figure 3. – Receiver Mode

If it is desired to operate the unit in "RECEIVER" mode, pressing the button next to the "SETTINGS" option will allow changes in the Receiver settings. See Figure 4 below.

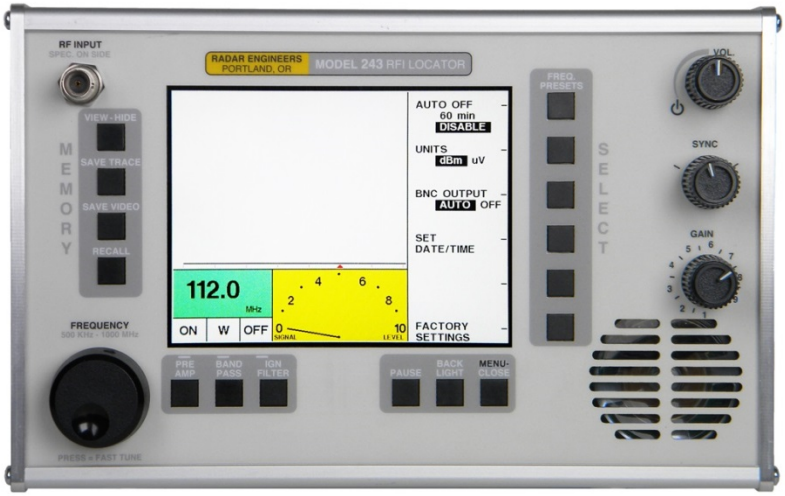


Figure 4. – Receiver Settings

AUTO OFF: In the "60 MIN" default position, the unit will turn off automatically if left on for 60 minutes. If the "DISABLE" option is selected, the unit will run until it is turned off, or until the battery is discharged.

UNITS: This setting allows the operator to select the signal level read out in dBm or in micro volts. dBm and µV level readings are approximate; +/- 2 dBm. Please note, the gain setting does not affect the dBM readout level. Signal levels are at the BNC input.

BNC OUTPUT: The amplified AM Probe is powered by 5VDC. That is supplied from the 243 via the BNC connector. In "Auto" mode the 243 will supply 5 VDC to the antenna input any time the unit is tuned between 500 KHz and 3.5 MHz. The operator can disable AUTO power mode by selecting OFF.

SET DATE/TIME: Provides for entering the date and time into the unit, which allows saved waveform files and videos to be correctly date and time tagged. This must be reset any time the battery pack is disconnected from the receiver.

FACTORY: Operating this pushbutton will bring up a message on the display: "HOLD FACTORY BUTTON TO SELECT FACTORY SETTINGS". This restores all MENU and front panel settings to factory default.

Pressing the "MENU-CLOSE" button closes whatever menu is open and returns the unit to operation.

SPECTRUM DISPLAY MODE: To place the unit in Spectrum Display Mode, press the button opposite "SPEC DISPLAY" shown in Figure 3. The menu will then disappear, and the unit will operate as a spectrum display. To change settings, press the "MENU-CLOSE" button again. When the menu appears, select "SETTINGS", and a sub menu will appear containing the available options for the spectrum display mode. See Figure 5 below.

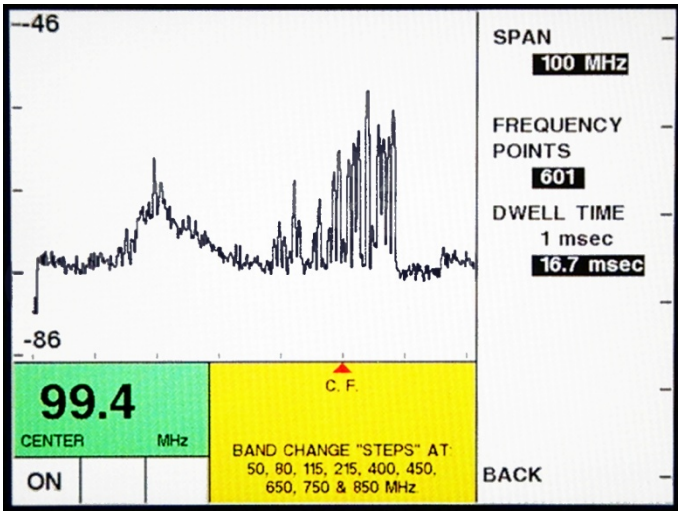
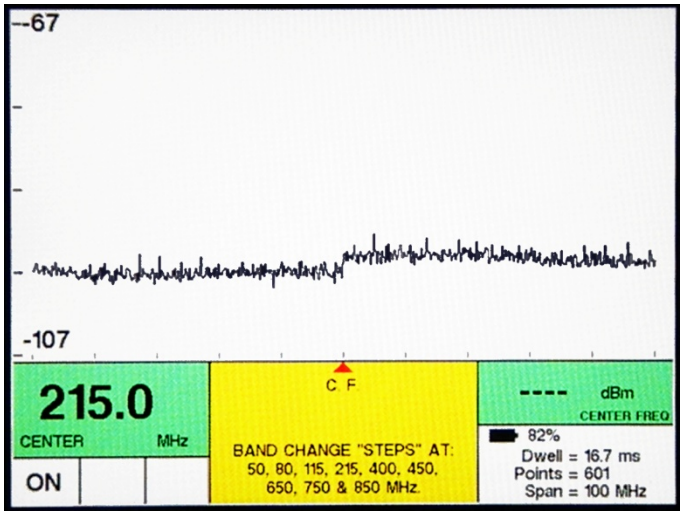


Figure 5 – Spectrum Settings

Span: This sets the frequency span for the display. The span widths available are 1, 2, 5, 10, 20, 50, 100 and 200 MHz, which are accessed by pressing the button next to the "SPAN" indication until the desired span is indicated.

Frequency Points: This setting determines how many points are sampled as the screen area is swept. The available points are 11, 21, 51, 101, 201 and 601. The more points sampled, the higher the resolution. The 601 setting is best for most applications. The sweep speed increases as the number of points is lowered.

Dwell Time: The dwell time also affects the sweep speed and resolution. The available settings are 1 millisecond and 20 milliseconds. For sparks the best setting is 20 ms.



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Center Frequency: The "center" of the frequency span selected by the operator is shown on the display as a number. And the location of the "center frequency" is marked by a red triangle in the yellow box. dBM readings are taken at the C.F. only.

Band Change Steps: There are a number of internal "band" changes over the wide frequency range of the Model 243. And there are a number of band pass filter changes. As a consequence there are frequencies where there are "steps" in the trace seen in the screen. Most are steps up. A few are steps down. The steps are identified in the yellow box.

IV. BATTERIES AND CHARGING: 

1. TYPE: Two banks of 8 AA NIMH rechargeable batteries power the Model 243.

2. BATTERY LIFE: About 5+ hours of continuous use. Approximate state of charge is indicated in the lower right corner of the display.

3. AC CHARGING:
   A. Recharge the batteries using the 15V AC adapter provided with the instrument.
   B. Best battery performance will be obtained if the instrument is discharged below 80% before recharging and then recharging to 100% whenever possible.
   C. Charge time is about 3.5 hours, then remove charger.

4. VEHICLE BATTERY OPERATION
   The Model 243 can be powered by a truck battery while the engine is running using the 12VDC "cigarette lighter" adapter provided with the instrument. Recharging is best accomplished using AC and the 15V AC adapter.

5. COMPLETE DISCHARGE/CYCLING:
   A. It is recommended that the NIMH batteries be cycled through at least one complete Charge/Discharge cycle every 2 months. This will help maintain battery performance over time.
   B. In the event that battery run time appears short, perform a complete charge/discharge/ charge cycle. Charge first for 3.5 hours. Then discharge the battery completely. (Disabling the "Auto Off" function in the Menu will simplify the discharging.) The complete discharge can take up to 6 hours. Now charge completely again.

6. SELF DISCHARGE: The AA batteries in this receiver will self-discharge at the rate of about 15% per month. Check the battery level before each field use and charge as needed.

7. TEMPERATURE: The model #243 stops charging if the instrument is below 32F or above about 122F. When charging is discontinued a message will appear on the display indicating it is "Too Hot" or "Too Cold".

8. REPLACEMENT:
   Do not remove or attempt to replace the batteries. Return the Model #243 to the factory for replacement.

V. SPARKING, CORONA AND ELECTRONIC SOURCES

A. Sparking

Spark gap 60Hz RFI can originate within the customer's home or on power lines. The resulting RFI will look and sound the same on affected equipment regardless of whether it originated indoors or outdoors. The actual source of this RFI is an electrical spark that is synchronous with the power line frequency of 60Hz. On distribution power lines the source is often a spark at a loose or corroded connection between two pieces of metallic hardware. Metal (or any conductor) in an electric or AC magnetic field will become electrically charged. When two pieces of metal are not making good contact they can become charged up to different voltage levels, and if this difference becomes large enough a spark will jump from one piece to the other. The spark will equalize the voltages and will self-extinguish, which allows the voltage difference to build up again until another spark jumps across. This process will repeat one or many times during each cycle of the 60Hz power line. It is not necessary to have a high voltage between the two pieces of metal. If the gap is small, a spark and RFI may be created with less than 200 volts. The magnitude of the voltage difference may affect the strength of an RFI source, that is, the distance it radiates, but the basic characteristics will be the same. Common locations for powerline sparks follow.

1. Loose Hardware.
2. Loose Tie-Wire on Conductor.
3. Tie-Wire on Insulated Conductor.
4. Guy Wire Touching Cross-Arm Brace or Neutral.
5. Corroded and/or Loose Pin in Bell Insulator.
6. Conductor Loose in Post Insulator Clamp.
7. Clamp Loose in Pivot Screws, Post Insulator.
8. Insufficient Clearance on Wood Surface between Hardware Parts.
9. Insufficient Clearance, Internal Hardware.
10. Corroded or Loose Hot-Line Clamp.
11. Loose Tie-Wire on Porcelain.
12. Loose Connection to Neutral Conductor.
13. Ground Wire Loose in Staple.
14. Loose or Corroded Ground Wire Splice.
15. Foreign Object (Trash) on Conductor.

Other common spark sources, not shown below, include lightening arrestors and cracked insulators.

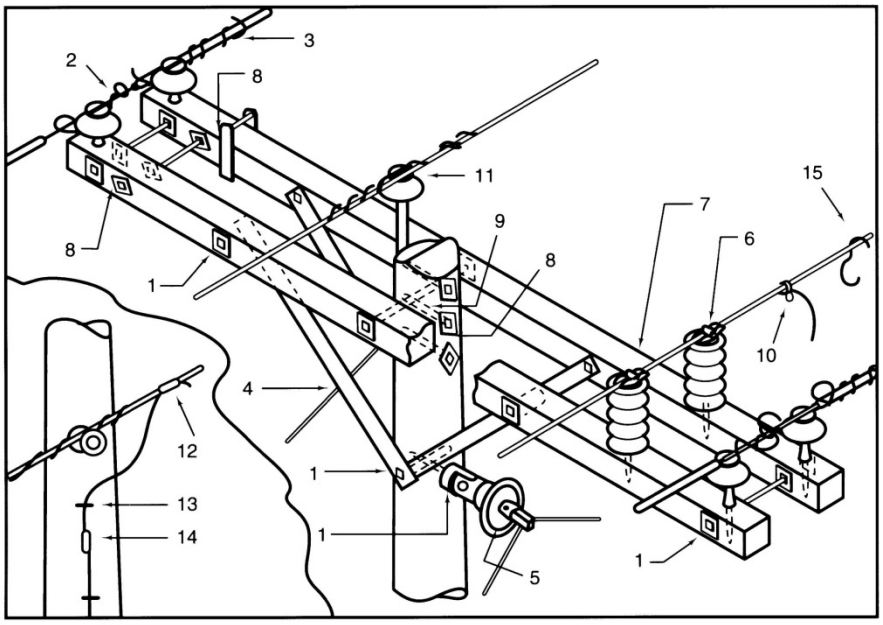


Figure 7 – Power Line Sparking Sources

Indoor sparking sources are often caused by pitted contacts or worn commutators/brushes. These sparking sources radiate broadband noise just like powerline sparks.

Examples of indoor devices that can cause sparking:

- Fish tank thermostats
- Doorbell transformers
- Electric fans
- Water heater thermostats
- Electric blankets

1. Spark Source Frequency

The following general principles form the background for effective use of the instrument:

a. Sparking is Broadband: A single sparking source usually generates detectable RF interference on most frequencies from 100 KHz to over 400 MHz and at times to 1 GHZ. (Hence, there is no single frequency for RFI locating).

b. Lower frequencies from an RFI source can be detected farther from the source than the higher frequencies. For example, the 300MHz component of a sparking source is usually detected within 6-8 poles from the source, whereas the 1 MHz component may be detectable miles from the source, in some cases. Therefore, the higher the frequency you can use to locate a source, the more sure you are of your locate. If you can detect a source at or above 300 MHz you are usually within walking distance.

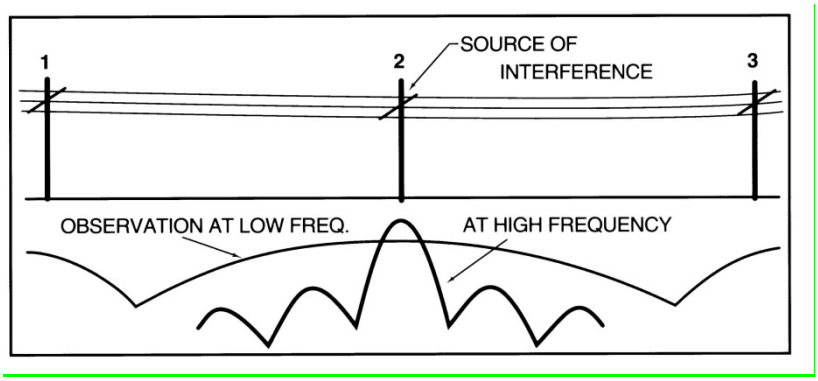


Figure 8 - Low and High Noise Frequencies Observed Along Line from Single Source.

The radiation of noise frequencies from a wood pole line is shown above, with a single source present in the section of concern. This illustrates the importance of using as high a frequency as possible for locating the source pole. The low frequency can radiate a long distance while the higher UHF frequencies exists (and can be detected) only near the source.

2. Pulse Groups

When observed on an oscilloscope or on the 243 Receiver power line sparking is usually distinctive in form and repetition:

Form: A spark has a steep rise time which appears as a vertical spike on the oscilloscope type display on the Model 243.

Repetition: The spikes occur toward the peaks of the positive and negative 60 Hz half cycles. As a result sparking typically appears in pulse group pairs. Each pulse group consists of several spikes or discharges. The number of spikes per pulse group and their spacing varies from one source to another source. Figure 9, 10 and 11 are typical power line sparking patterns. Figure 9 shows denser pulse groups indicating a narrow spark gap. In Figure 10 we see pulse groups where spark gap spacing is wide and there are few spikes per group. The investigator will often see several variations of power line noise pulse groups during a search. Near the voltage zero crossing there will be no discharges.

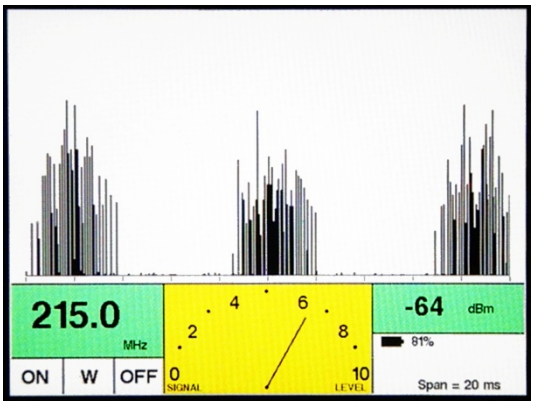


Figure 9 - 60Hz Pulse Groups

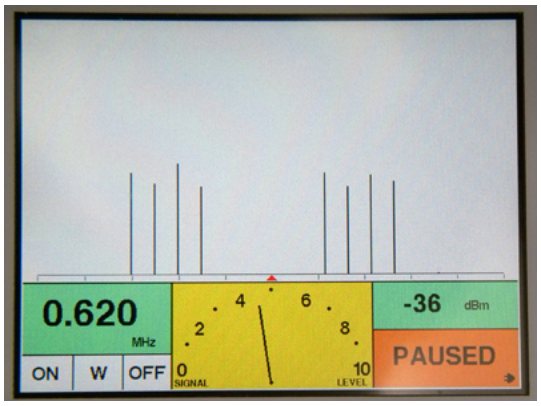


Figure 10 - 60Hz Pulse Groups

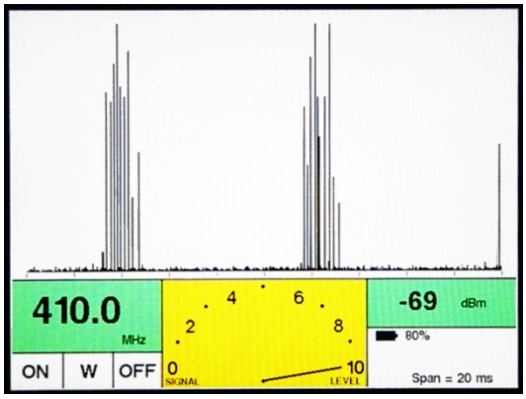


Figure 11 - 60Hz Pulse Groups

The Pulse group from a sparking source does not usually change much in appearance over a short time span, such as during the time it takes to do an RFI locate. (Of course, if it is very windy, the width of the spark gap could change causing a change in the number and spacing of the spikes.)

A pulse group does not usually change much in appearance as the frequency changes. For example, a pulse group observed at 5MHz will look much the same at 125MHz and 650MHz. See Figures 12, 13 and 14 below. The pulse groups may not be identical at different frequencies, but they will usually be similar enough to each other and different enough from other sources to allow you to track one particular source.

There are enough possible 60Hz pulse group patterns (number of pulses and spacing) that once an RFI pulse group is identified to be of interest it is usually distinguishable from all other pulse groups generated from other sources in the same neighborhood. Each sparking source can be said to have a temporary “footprint”.

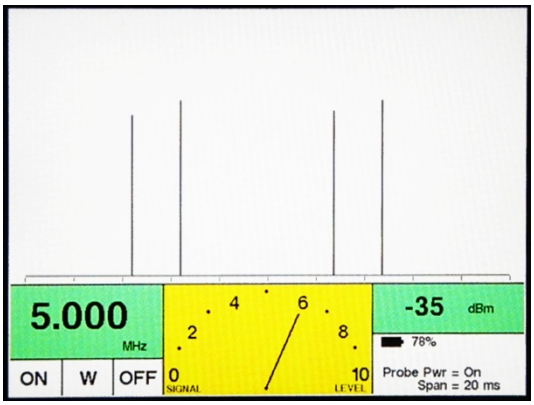


Figure 12 – Pulse Groups at 5MHz

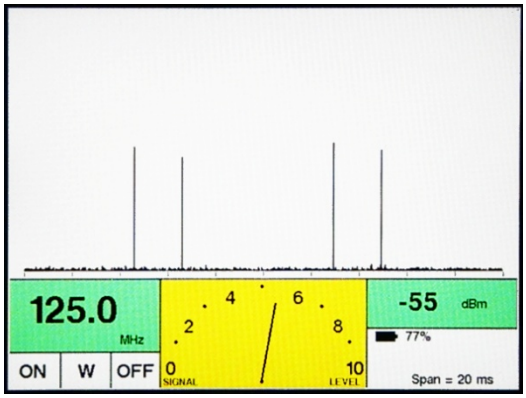


Figure 13 – Pulse Groups at 120MHz

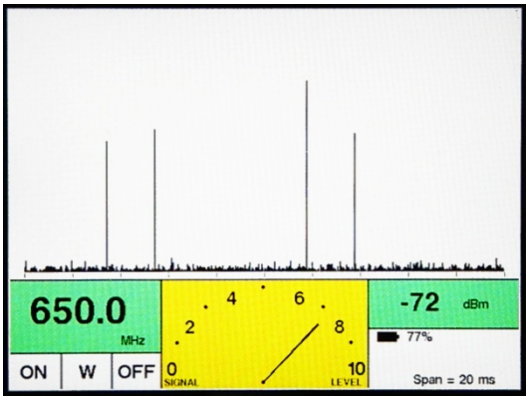


Figure 14 – Pulse Groups at 650MHz

It should be noted that a pulse group is constantly changing in minor ways: The same source can have 5 pulses per half cycle one second and 6 pulses the next. The positive half cycle often contains more pulses than the negative half cycle.

A pulse can change in major ways. The wind can shut them off or cause a change in the gap size and therefore, cause a change in the number and spacing of the spikes.

If a source is rectified only the positive half cycle of a sparking source will generate observable pulses. See Figure 15.

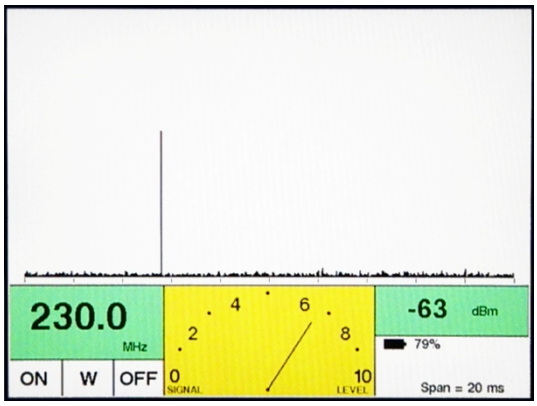


Figure 15 - Rectified RFI Source

Pulse groups cannot usually be used to predict the type of hardware causing a spark. It is not possible, for example, to say 2 spikes per half cycle are deadend bells and 3 spikes are lightning arrestors.

There is an exception to every rule, when chasing sparking sources.

3. Factors Affecting Spark Gap RFI

a. Rain Humidity: Rain can complicate RFI locating because moisture normally shorts out the small gaps and suppresses sparking. After rain starts, it may take an hour or more for the sparking gap to be shorted out. Thus, interference can continue for limited periods during foul weather. Conversely, after a rain or heavy dew, hardware sparking will not ordinarily reappear until the moisture has evaporated.

b. Tracking: The discharges that occur in a tracking path often do not follow the same rules as a hardware spark. For example, unless a tracking path is fully carbonized, some moisture (and contamination) is needed for tracking to occur. For this reason, many tracking sources only appear early in the morning when there is dew. Then micro gaps in the current path act like spark gaps that create RFI. Once fully carbonized tracking can be less weather dependent. See also VI.C.2.

c. Wind: Wind pressure on cross arms and conductors can change the size of a spark gap and thereby cause sparking to stop or start.

d. Enclosed Discharges: Sparking that occurs inside a metal enclosure, such as a transformer, presents special problems. Fortunately, such sparking is not common. In the case of a pole transformer with internal sparking, the VHF output from the source is usually quite weak.

B. Corona Sources

Corona is a point discharge. The discharge off the end of a sharp object at very high voltage is an example of corona. Sparking is caused by a discharge across a gap, which is usually very small. The difference between corona (point discharge) and sparking (gap discharge) is significant. Corona usually does not radiate beyond a few blocks. And it is not usually detectable above 200 MHz. Spark gap noise can propagate for miles and is usually detectable at UHF frequencies if the operator is close enough.

Corona may be classified as being either the foul-weather or the fair-weather type. In foul-weather on extra high voltage transmission lines (above 230Kv) water droplets on a conductor are distorted into pointed shapes and corona will emanate from these points. Thousands of corona plumes may be present on a transmission span, causing radio and UHF interference to nearby residences. When foul-weather corona interference is present, it will be obvious all along the EHV conductor and will not be a locating problem.

Fair weather Corona can be caused by frayed conductors, sharp corners on hardware, sharp mold nibs on vibrator dampers and foreign objects on a transmission level conductor. Fair weather Corona may cause radio interference. However, it does not usually cause UHF television interference because radiation from a point corona source is very weak at high frequencies.

Corona is a 60 Hz event and is usually only seen in one half cycle.

C. Electronic Component Sources and Carriers

Electronic components, such as SCR's, do not actually spark, but their extremely rapid current switching can have a similar RFI effect and appearance. Electronic noise can also be broadband, but is not ordinarily detected or a problem above about 75 MHz.

Examples of equipment that can electronically generate interference:

- Touch lamps
- UPS systems
- Fluorescent lights
- Photo electric device
- Variable speed motor drives
- Light dimmer controls
- Ultrasonic pest control devices
- VCR's
- Electronic air filters

Indoor sources can interfere with radio and TV reception. Indoor sources can also jam electronic systems, like computer control systems, that transmit or receive data via indoor wiring.

Unlike spark gap noise, electronic sources do not usually propagate noise very far, typically, only a couple of houses from the source. Many electronic sources sound like spark gap noise and many present a vertical spike like spark gap noise because of the fast current switching rise time.

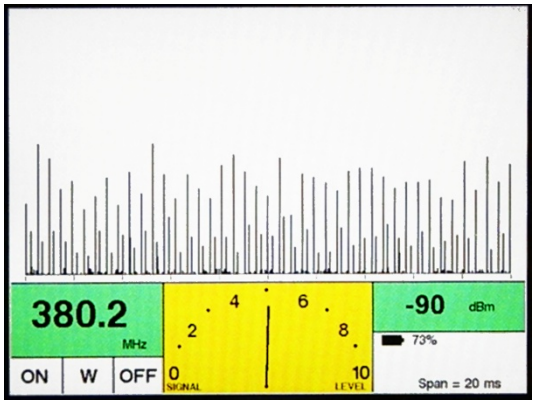


Figure 16- Electronic Noise

As noted above, you would not ordinarily expect to detect electronic noise above 75MHz. However in this case of an optical mouse, the interference was at a much higher frequency.

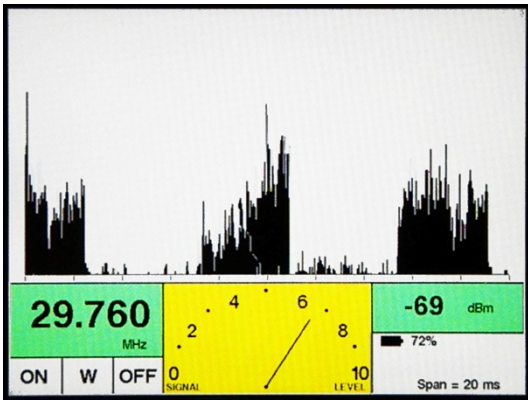


Figure 17- Touch Lamp On

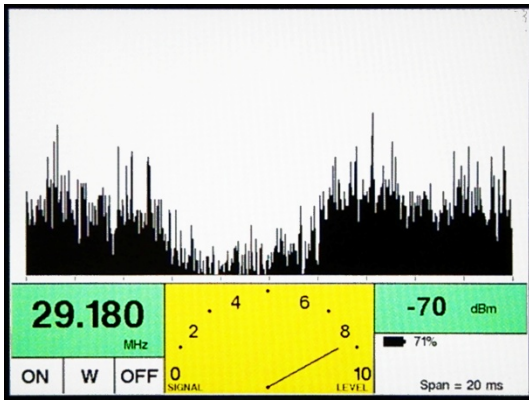


Figure 18 – Touch Lamp –Off-Oscillator

There is a subset of electronic sources that do not have a steep rise time, such as free running oscillators. These oscillators can be found in touch lamps and are running even when the lamp is off. The appearance of these sources is different than sparks or SCR's Special attention needs to be paid to detect them. They do not appear as spikes in pulse groups. See Figure 18. In addition, they are not present at all frequencies like a spark. They have a fundamental harmonic which repeats multiples of its frequency. The effect on the LCD is a source that appears and disappears every 130 KHz or so. The waveform looks something like a caterpillar as you slowly change the frequency. In addition, the meter will react strongly to these sources even if the audio and video reaction appears weak. Like other electronic sources these oscillator sources do not usually radiate noise above 75 MHz.

With a few exceptions powerline spark pulse groups do not look like broadcast signals. See AM and FM Radio signals in Figures 19 and 20 below. Neither sounds like powerline RFI either.

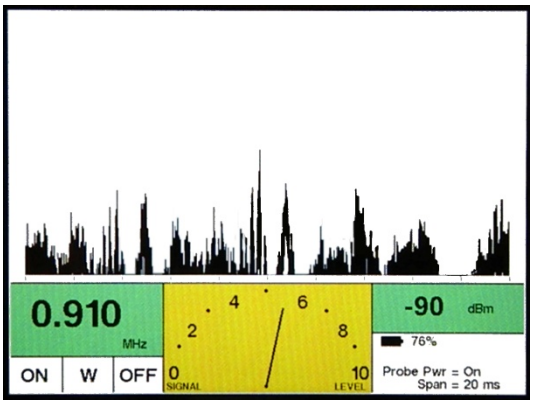


Figure 19 – AM Radio Signal 0.910MHz

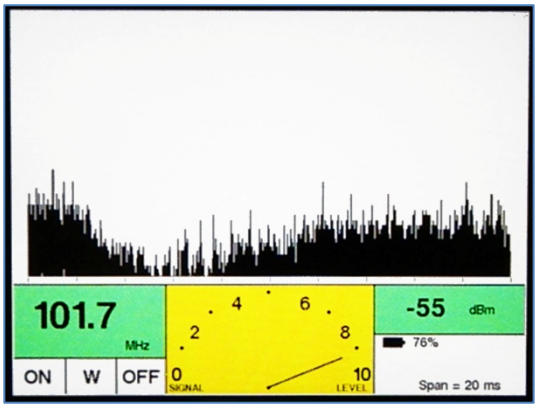


Figure 20 - FM Waveform

VI. LOCATING INTERFERENCE SOURCES WITH THE MODEL 243

A. Locating Powerline Sparks

1. Before beginning your search, verify with the customer that the source which is causing the problem is actually "on". If it is not, and you search anyway, you will likely find something but it will not be what is bothering your customer.

2. Rule out the customer's home as a source of the RFI. About half of all radio noise complaints are caused by electronic sources inside the customer's home or the home of a neighbor.

3. Observe pulse groups using the customer's antenna**:** If there is access to a customer's HAM or TV antenna, plug it into the Model 243. Tune to a frequency near what your customer is using. This will allow the interference the customer is complaining about to be seen. Try using both wide and narrow band pass settings. If you can see the source on the narrow setting and can confirm with the Ham that it sounds the same as what is heard on his receiver, then use that signature. You will see a "signature" to store in memory. Then, when you are searching the neighborhood you have a reference waveform that will provide a ballpark idea of what to look for. It should also allow you to ignore those sources that are present on every distribution system but not causing your customer's interference.

4. Move to the front yard. Connect the handheld 270-1000MHz. Do a 360° scan at 270 MHz. If you detect the source it is usually within walking distance.

5. If the source is not detected with the hand held antenna, connect to the mag mount car whip antenna and begin a vehicle search.

6. To start with, select the highest frequency which the interference can be received with your magnet mount antenna. If the interference is not received set the locator at 150 MHz, set the gain at level 9 and drive in a pattern spiraling out from your customer until the interference can be received. Listen for the distinctive arcing sound. Some say it sounds like bacon frying. Most commercial transmissions sound distinctly different from arcing. Commercial transmissions are generally repetitive and predictable. Stop and compare the signature of the received signal with the stored reference signal.

7. As you get closer to a source you will be able to increase the frequency on the 243. (In fact, the operator can use frequency as a means of attenuating the signal rather than using the gain pot.) Most of the time, you should be able to tune up to over 300 MHz before getting out of your vehicle. (Some operators use the preset frequencies to quickly check detectable frequencies. For example, they may try at 3.5MHz, 45MHz, 135MHz, 255MHz and 355MHz. Approaching the source it can be detected at higher and higher frequencies.)

   Pinpoint the pole – once a source is detected over about 300 MHz with the whip antenna, a couple of passes can be made at higher frequencies to improve

resolution. Still the exact structure from which the arcing originates needs to be determined. Exit the vehicle. Connect the handheld directional antenna.

When using the handheld log antenna, tune the receiver to 270Mhz to start with. Then increase the frequency. Tune slowly up to 300 or 400MHz. If you can still pick the source up, move higher yet, for example, to 600 or 700MHz. Remember, the higher the frequency, the closer you are to the source and the better your resolution, though not all sources can be detected above 300MHz.

To distinguish the actual source from a re-radiated source, stand across the street and halfway between the suspect poles. (Never stand directly under the powerline.) Point the antenna at one pole then the other. Walk in the direction of the strongest signal level and repeat the process at the next two poles. Continue in this fashion until the meter reading indicates you have passed the source. The pole with the strongest signal is the source pole. See Figure 21.

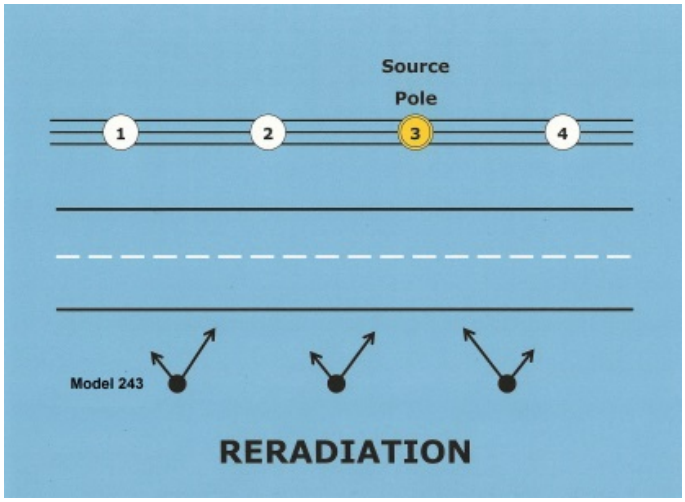


Figure 21 – Identify the Pole

9. Misc:

   Multiple sources: It is not uncommon to encounter more than one source of RFI. If you have stored a reference waveform, stay focused on finding its source. If you did not store a waveform, first locate the source with the highest signal strength reading. It is likely to be the source bothering your customer.

   Rotate the antenna on its axis: Some sources are more easily detected with the antenna elements horizontal and others are more easily detected with the elements oriented vertically. The antenna position that brings in the most signal should be used to locate the source.

Antenna lobes: Directional antennas are most sensitive off the front end of the antenna. This is called the front lobe. But there are also small side and back lobes that can pick up RFI. To verify that a noise is not being picked up off a side or back lobe, decrease your RF gain until you can pick up the source when pointed in only one direction.

B. Locating Electronic Sources

There are many instances of electronic equipment causing radio interference affecting AM radios, amateur radio reception, and high speed internet service (DSL.) The radio interference levels affecting AM radio and DSL service are usually fairly high, while radio interference levels affecting amateur radio can be much lower.

The source of these electronic interference problems is usually within the home of the person making the complaint, or coming from a neighbor's residence served by the same transformer.

If the interference complaint is from a ham operator; ask the operator to bring up the interference on his ham receiver in the AM mode if the receiver has an AM position. This will make it easier to compare the audio component with the one received with the Model 243 RFI locator. If the ham receiver does not have an AM position, just listen to the noise received on the ham receiver for comparison.

Set the Model 243 for the frequency received on the ham receiver. Connect the 243 to the ham radio station antenna and look for the interference being received on the ham receiver. Try first in wide band, and then narrow band. If the signal is easily received in narrow band, use this setting for locating the RFI source. Note the waveform shown on the 243 display. Listen to the audio and compare to the audio received on the ham receiver. Make sure that the offending signal is the one being looked at, as more than one signal may be present, especially in wide band mode. Save the waveform in one of the memory positions. Ask the ham radio operator if there are any powered amplifiers in the antenna circuit that would be affected by turning the main power off. If not, ask permission to turn the main power off to the residence. Then check the Model 243 RFI locator. If the RFI signal is still present, the source is external to the residence. If it disappears, then the RFI source is in the ham operator's residence. The source can be determined closing the main breaker and then checking all the individual circuit breakers in the home.

If the RFI source is external to the home where the complaint is, with the vehicle next to the home in the driveway, using the mag mount whip antenna on the vehicle, attempt to receive the RFI with the 243 locator in the vehicle, starting with the frequency most affected. If the signal is observed, and the waveform on the display matches the one received in the home, increase the frequency as high as can be easily received and set the meter level for around 50%. Then exit the driveway and drive up and down the street on both sides to see where the signal is strongest. The source of the signal could be several blocks away.

NOTE: If the power service is overhead, and the signal is in the power wiring, the signal will go up when the whip antenna is close to service drops to homes and will have to be taken into consideration during the locate operation. Then enter the driveway of the nearest residence where the signal is strongest. If this residence is where the RFI source is, the level should increase rapidly as the vehicle moves closer to the residence. Then get out of the vehicle, and use the AM Probe or a portable whip antenna on a coaxial cable attached to the 243 locator. The level should get even stronger the closer to the residence. The power meter and telephone/cable terminal should be checked for RFI level also.

If the RFI signal cannot be received in the vehicle as described above, try driving around the neighborhood in wider and wider circles until the signal can be received on the Model 243 locator in the vehicle. Once the RFI signal is received, then drive up and down both sides of the street to determine the spot where it is strongest. Then drive up as close to the building where the signal is strongest as possible. As the locator gets closer to the source, the level should increase dramatically. Once the vehicle is as close as possible, get out of the vehicle and use a portable whip antenna on a coaxial cable connected to the 243 locator to verify the RFI source location.

C. Locating Powerline Maintenance Issues

The Model 243 can be used to assist with maintenance or preventive maintenance.

1. When To Look For Sparks of Any Kind:

The only time a sparking source can be detected is when it is "ON" and radiating RFI.

Many "loose hardware sparks", such as induced voltage discharges (nuts and washers, V braces etc.) turn on and off with moisture, wind, etc. Moisture generally turns off loose supporting hardware sparks by shorting out the gap. However, moisture often has no impact on " maintenance" type sparks (arcing hot clamps, lightening arrestors, arcing automatic splices etc.).They often come on and stay on regardless of moisture. On the other hand, "tracking" sources often require some moisture to turn on, at least until the tracking path has carbonized. Dew in the morning can facilitate tracking. So can a small rain shower after an extended dry spell.

So if the goal is to find loose hardware, then the search would usually be done in the afternoon when weather is good and after the moisture/dew has burned off. If the goal is to find tracking on insulators then it is often the case that doing a survey early in the morning before the dew has burned off or after a small rain shower could give better results.

Because there can be substantial variability in the conditions giving rise to discharges some utilities do survey runs on the same powerline at different times of day and under different weather conditions to minimize the chance of missing something. In those cases where a utility has system records of the time of day when "operations/blinks" occur then the recorded time of day is likely the best time to do the search.

2. Frequency:

Hardware Spark Gap Sources: Hardware spark gap sources (loose hardware, lightening arrestors, hot clamps etc.) are usually detectable over 300 MHz, provided you are close enough to the source.

Tracking: Tracking is often not detectable above 150 MHz (unless the tracking path is fully carbonized) and in some cases not above 5 MHz. There are no hard and fast rules here. You may need to experiment and balance the pros and cons of lower frequency surveys (which may detect more than you are interested in) and higher frequency surveys that provide better resolution but may be above the frequency of a specific tracking source. Some utilities will survey the same pole line at several different frequencies to minimize missing sources, for example, at 45 MHz, 150 MHz and 300 MHz.

Corona or Point Discharges: Point discharges typically occur on 115 KV lines and up. Corona is usually not detectable much above 200 MHz. Corona is also characterized by the fact it is only detectable in one half cycle, whereas, most spark gap discharges are seen in both half cycles. This is readily observable on the display of the Model 243.

3. Signatures / Pinpointing:

Sparking sources have a characteristic appearance marked by one or more discharges per half cycle, then dead space where there is no voltage, followed by one or more discharges in the other half cycle. For a particular source the numbers of discharges in each half cycle is usually similar. This is also true for tracking. There is no reliable way to say that one "signature" is a V brace and another a lightning arrestor. That means the operator will need to identify the sparking sources detected to determine if they are loose hardware, discharging lightning arrestors, etc., or tracking. The hand held log periodic antenna used with the Model 242 is good for figuring out which pole has a spark. It is not useful at pinpointing the specific piece of hardware; the beam width is too wide. To pinpoint and identify the sparking source requires another tool, such as our model 250 or 247B.

VII. WARRANTY AND NOTICE TO PURCHASER

All electronic products manufactured by Radar Engineers are warranted against all defects in material and workmanship for a period of one year following shipment. Our liability is specifically limited to replacing or repairing, at our option, defective equipment. THIS WARRANTY IS MADE IN LIEW OF ANY OTHER WARRANTY EXPRESSED OR IMPLIED, INCLUDING BUT NOT LIMITED TO, ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITTNESS FOR A PARTICULAR PURPOSE. Neither seller nor manufacturer shall be liable for any injury, loss or damage, direct or consequential arising out of the use of this product.

All statement, technical information and recommendations contained herein are based on information believed to be reliable, but the accuracy or completeness thereof is not guaranteed. Before using, the user shall determine the suitability of the product for his intended use, and the user assumes all risk and liability whatsoever in connection therewith.

All statements or recommendations not contained herein shall have no force or effect unless in an agreement signed by offers of seller and manufacturer.

VIII. REPAIRS AND CUSTOMER SERVICE

Radar Engineers maintains a complete instrument repair service. Should this instrument ever require repairs, do not attempt to repair it yourself. Return it to the following address:

RADAR ENGINEERS INC
9535 N.E. Colfax Street
Portland, OR 97220

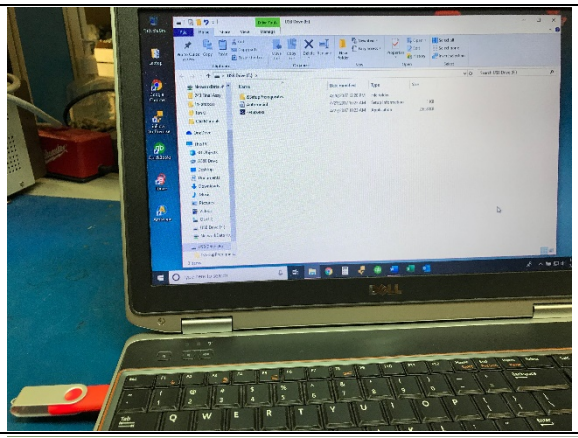
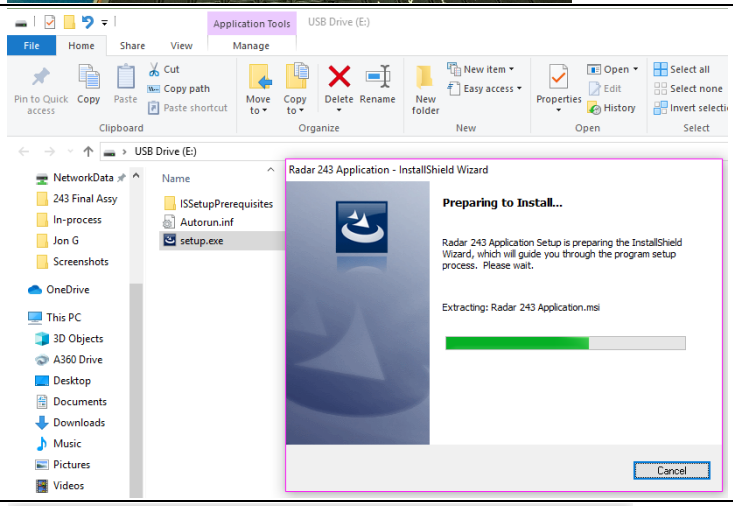
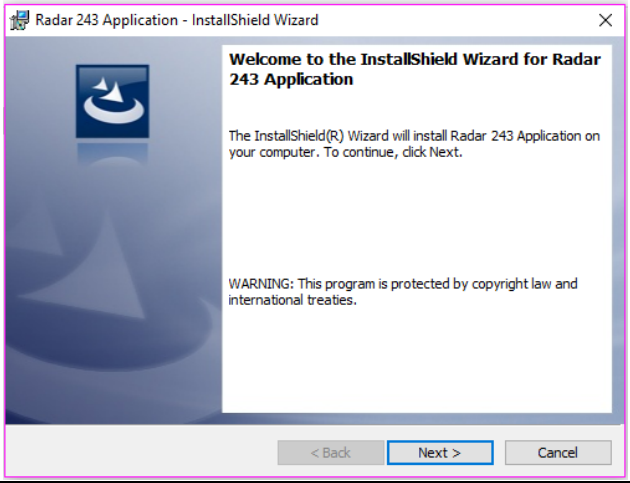
When returning the instrument for repairs, it should be shipped in a protective container Prepaid and Insured. A note should be included describing the defect and the name and telephone number of the person to contact in case additional information is needed.

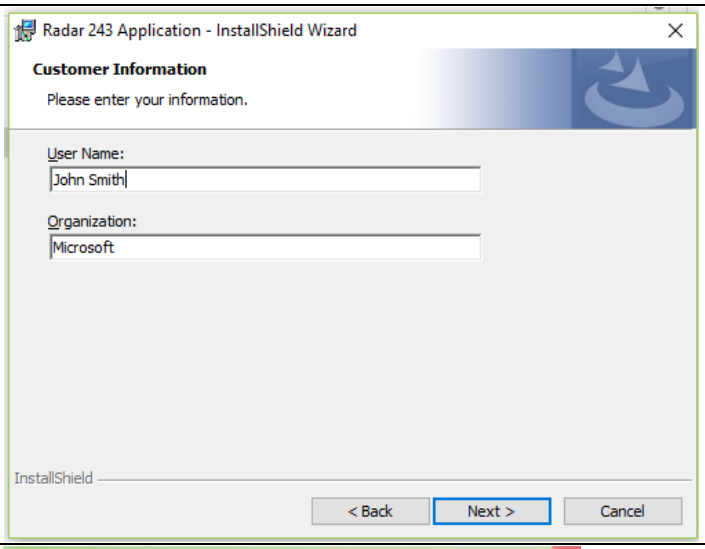
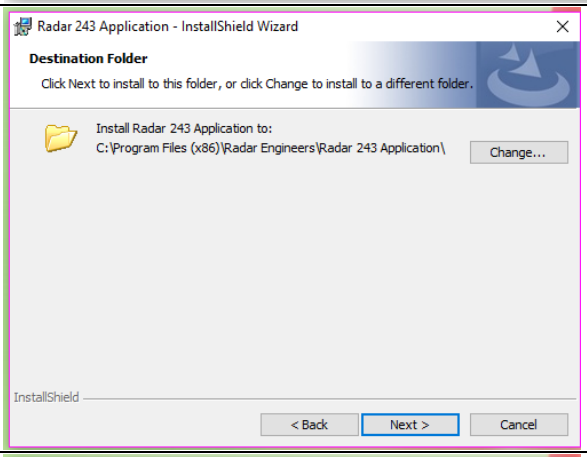
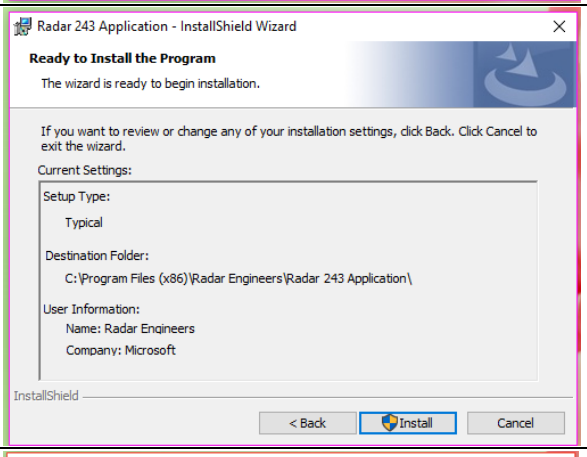
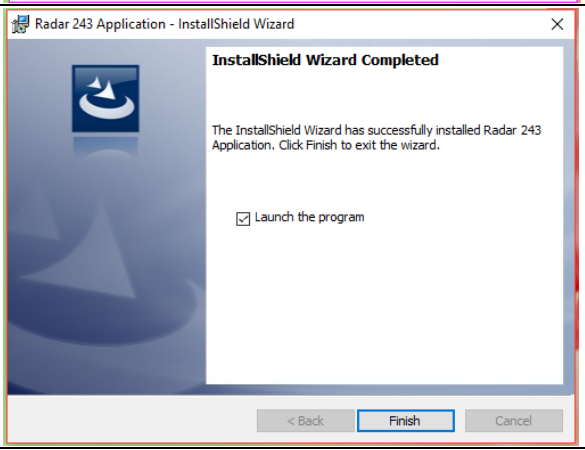
If you have questions regarding the operation of the instrument, call Radar Engineers at; (503) 256-3417.

10/04/2022

Model 243 Uploader
Installation Instructions & User Guide

This program runs on Windows XP, Windows 7, 8 & 10 Operating Systems.
Do not plug the instrument into your computer until installation is complete.
If you have an older version of the uploader installed go to “Control Panel”, then “Programs”, then “Programs and Features” and uninstall the previous version first.

	PROCEDURE	ILLUSTRATION
1.	**Insert the flash drive into a USB port on your computer.** The drive should automatically open. If it doesn’t, access the “File Explorer”, select “My PC” and click on the “USB Drive” to open it.	
2.	**Click on Setup.exe to begin installation.** You may encounter the following message: “Radar 243 application requires the following items to be installed on your computer.” If so, click “Install” to begin installing these components.	
3.	The “Install Wizard” will open in a pop up. Click “Next”.	

4.	Enter your information in the “Customer Information” box. Click “Next”.	
5.	In the “Destination Folder” window, keep the default location that appears. Click “Next”.	
6.	A “Ready to Install the Program” window will open. Click “Install”.	
7.	The “InstallShield Wizard Completed” window will open. Uncheck the “Launch the Program” box if you do not wish to launch the program now. Click “Finish” to complete installation.	

USER GUIDE

The newly installed 243 application will allow instrument trace files and videos to be downloaded, viewed and stored. The application also allows you to export files in several forms and print displays.

Types of Files

- Trace files in their native form start with R (receiver) or S (spectrum), the date and time they were saved and have the extension "**.rtr**" (Radar Trace).
- Videos start with V and have the extension "**.rvb**" (Radar video). When files are imported they are displayed in a tree form on the left side of the window where they can be selected for display.
- When a set of files are stored with the "Save" or "Save As" command they are stored in the form of a single data set "**.rwd**". (Radar Waveform Document)

Note: make sure date and time are correct on the 243 for the time stamp to be correct.

Export files using a USB cable:
Receiver and spectrum trace files can be imported directly from the instrument by connecting a USB cable from the PC to the 243 mini USB connector. Under the File tab use the "**Get Data from Instrument**". Select files and download. Video files can only be transferred with a Thumb Drive.

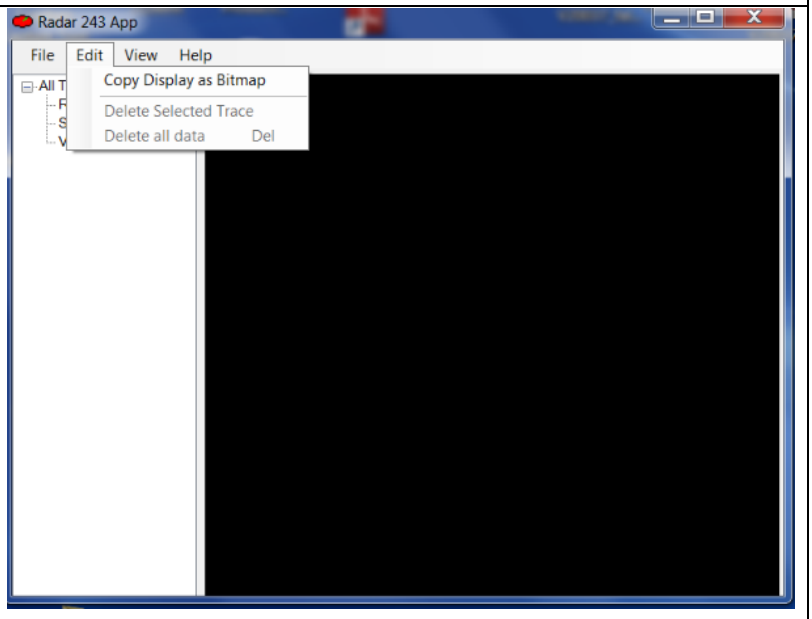
To Export files from the 243 using a Thumb Drive: Insert thumb drive into standard USB slot on the 243. On the 243 press "Menu" then "Export MEMS to USB" It may take a brief moment to start and complete the transfer. Move the thumb drive to the target PC. The folder on the drive can be saved to a file on the PC or directly imported to the application using the "**Import Data from File**". You can select individual files or import all files from the folder.

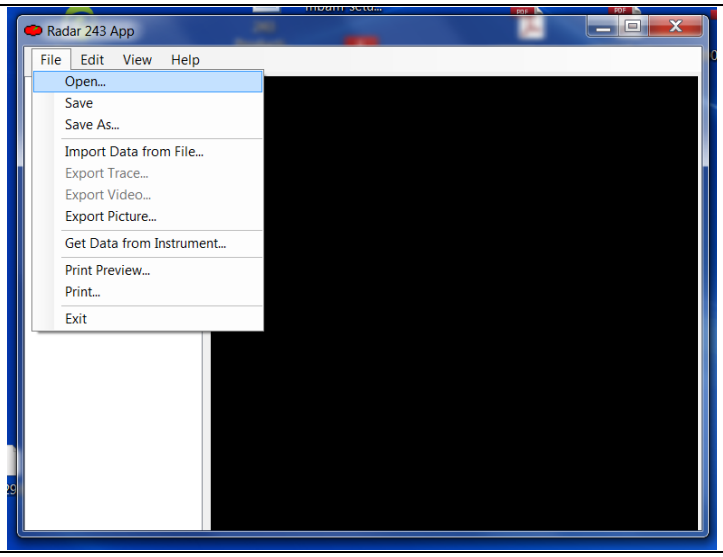
To access data from a file on a PC: If files are saved from the application as a ".rwd" document they can only be opened with the "Open" command.

If files are saved in the ".rtr" or ".rvb" format they can only be opened with the "Import Data from File" command.

Edit Tab

- **"Copy Display as Bitmap"** takes a screenshot of the display.
- "**Delete Selected Trace"** Select and delete unwanted traces.
- "**Delete all data**"





File Tab

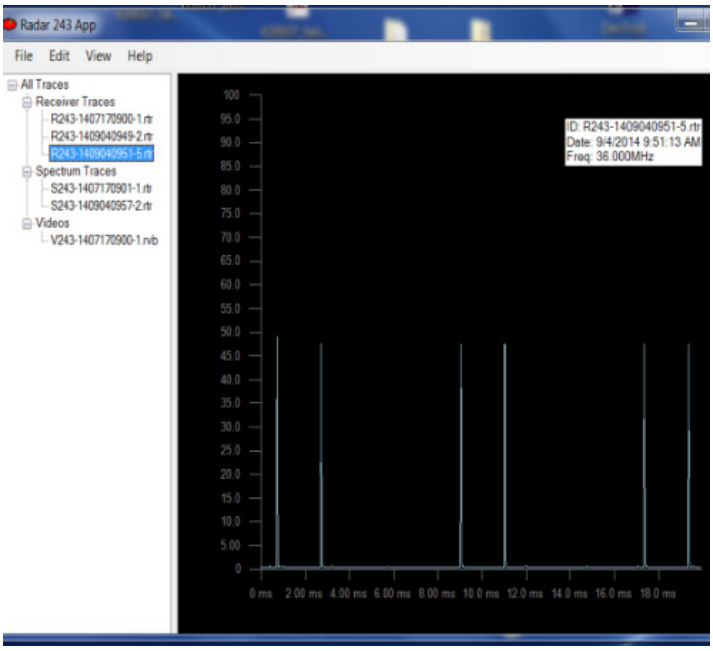
- "**Open**" This command is used to bring in only ".rwd" file sets that have been previously "saved" from the application. It will not work with other file formats. This command is a replace command and will replace the current files shown with a different set of files.
- "**Save**" and "**Save As**" commands are used to save the files that are currently in the trace tree as a set in one document ".rwd". This is a convenient way to name and store a set of files. If there are many videos in this set it can be slow to reload.
- "**Import Data from File**" This command is used to import files from a Thumb drive or disk location that are in the trace or video form ".rtr" or "rvb". One or more files may be selected and imported at one time.
- "**Export Trace**" When present in the 243 application this command allows a selected trace to be exported to a folder in the ".rtr" format.
- "**Export Video**" When present in the 243 application this command allows a selected video to be exported to a folder in ".rvb "or ".avi" format.
- "**Export Picture"** This allows the current display to be exported in ".bmp", ".jpg", ".png", ".gif", or ".emf" format.
- **"Get Data from Instrument"** This command is used to import files directly from the instrument with a USB cable connected to the 243 mini USB port. You can select individual or all traces stored on the 243. This only works with trace files and not videos. Transferring videos require the use of a thumb drive
- "**Print Preview**" Preview of how print will look.
- "**Print**" Print displayed traces.
- "**Exit**" Exit program.

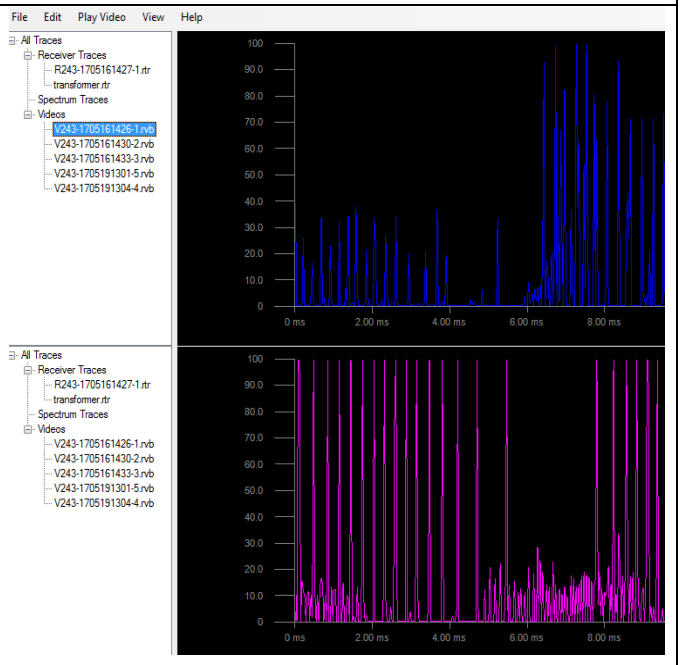
View Tab

The View Tab allows you to switch between split screen and single screen viewing mode.

To choose what file is being displayed in View Mode select from the trace tree to the left.

When a video is selected a Play Video Tab will appear in the menu bar from which you can run the video.





Important Notes

- "Save" and "Save As" save all files in the trace tree as a single data file ".rwd" extension. It can only be brought back in with the "Open" command and will replace all the current files in the tree.
- "Import Data from file" Only works with data in the ".rtr" or ".rvb" file format and will not work with ".rwd" files.
- It may be helpful to transfer files from the thumb drive to a folder where the individual files can be renamed to a more descriptive name, keeping the file extension such as "327 Oak-pole.rtr" and the folder could be named "Oak St June 12". (The files could also be renamed on the thumb drive if desired.)
- Another advantage to using a folder rather than the applications "Save "function (.rwd files) is that they will load much faster. They are loaded just like from the thumb drive using the "Import Data from File".