INSTRUCTION MANUAL

MODEL M-331
MINI RFI LOCATOR

RADAR ENGINEERS INC
9535 N.E. COLFAX STREET
PORTLAND OR 97220

M-331 FIELD INSTRUCTIONS

SAFETY:

Follow All Safety Rules and Procedures.
These Antennas Are NOT Insulated.
Maintain Safe Work Distances At All Times.
The M-331 Is Not A Voltage Sensor.

BACKGROUND:

- Powerline sparks are broadband.
- A spark that interferes with AM radio at 1 MHz, a Ham Radio at 3.5 MHz or CAT**V** at 30 MHz will also be detectable at 330 MHz if the M-331 is within about a few poles of the source.
- The only time to look for a spark is when it is "ON".
- The M-331 is optimized for sparks NOT electronic sources.

1. M-331 USE:

A. Battery: The instrument uses a 9V alkaline battery. It is good for about 8 hours of use. Battery level is displayed on the LCD when the instrument is first turned on.

B. Frequency Pot: The M331 is most sensitive between 9:00 and 3:00. Tuning range is roughly 320 – 340 MHz.

C. Gain Pot: Set gain at Max to start. Reduce if meter pegs or if ignition or background noise is too high. If a spark is detected with gain at max, the source pole should not be more than about 6-8 poles away. Gain setting threshold is displayed for a few seconds on the left of the LCD, when the gain is changed.

D. Ignition Filter: Digital Ignition Filter reduces the audio distraction of nearby vehicle ignition noise.

E. Yagi Antenna: The antenna mounted to the receiver is a directional Yagi. Unscrew the antenna handle and rotate it so the handle is perpendicular to the elements, then tighten.

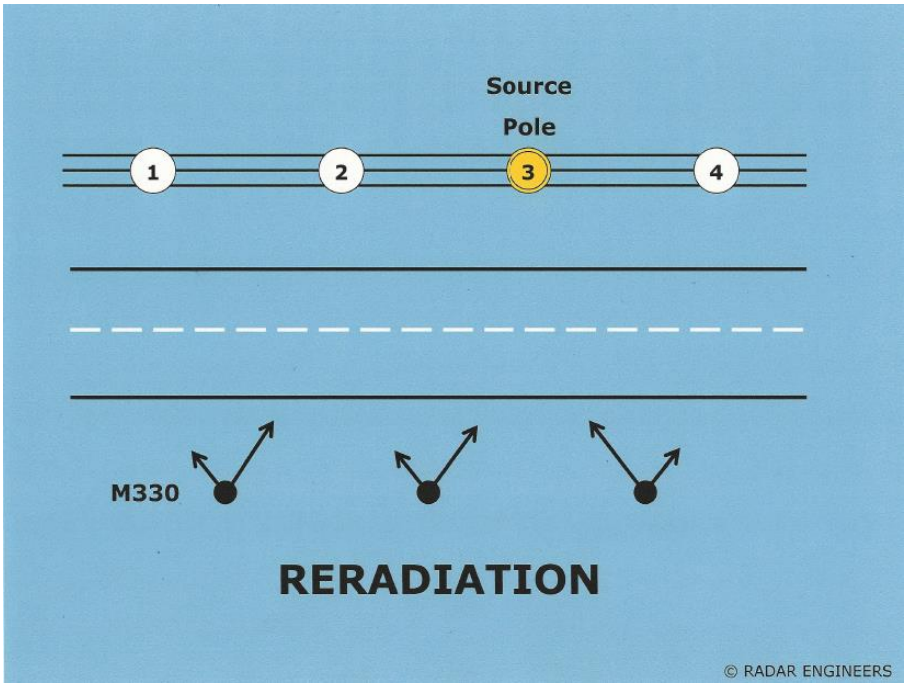
F. Polarity: Most sources are horizontally polarized. Some are vertically polarized. Rotate antenna on its axis for best reception.

G. Compare Signal Levels: Stand across the street, half way between two suspect poles:

Think tip of a triangle. See graphic below. Compare signal levels. If bar graph pegs reduce gain. Move in the direction of highest level and repeat comparisons until you have passed the source.

Do a 360 to confirm source is not coming from behind. It can sometimes be useful to get on the far side of the pole line and do a 360 there as well to eliminate the possibility that the source is in the next block.

Note: The closer you are to the powerline the less reliable the directional information.



Radar Engineers Inc 06/06/2022

TABLE OF CONTENTS

I. SAFETY NOTE 

The Model M-331 RFI Locator should be used from the ground level only. THIS INSTRUMENT IS NOT INSULATED. Safe working distances must be maintained from electrical conductors as electricity can jump to the antenna.

This instrument is not a voltage sensor. The presence of voltage will cause little, if any, response from the portable RFI locator. Exercise caution at all times to protect yourself from injury or electrocution. Follow all utility safety rules and procedures.

II. INTRODUCTION

The Model M-331 RFI Locator was designed to help utility crews efficiently locate the sources of power line sparking that cause radio and television interference (RFI/TVI).

The Mini Locator consists of a tunable receiver and an antenna covering the frequency range of approximately 320 to 340 MHz with the frequency adjustment control the operator is able to tune away from local transmitted frequencies and pick up existing power line sparking. Most sparking sources are detectable by the M-331 from three to four poles away.

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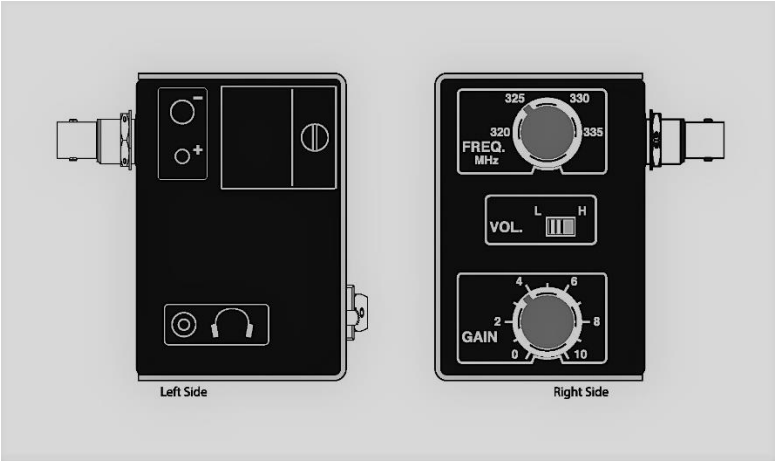
MODEL M331
RFI MINI LOCATOR
2 4 6 8 10 12 14 16
-90 dBm
IGN FILTER
POWER
RADAR ENGINEERS
PORTLAND, OR.


325
330
320
335
FREQ.
MHz
VOL.
L
H
4
6
2
8
GAIN
0
10
Left Side
Right Side

III. COMPONENTS OF THE MODEL M-331

ANTENNA INPUT BNC-connector is used for 50 ohm antenna input.

SIGNAL STRENGTH METER The LCD bar graph meter reflects the relative strength of signal or noise detected by the instrument. A calibrated signal strength read out is displayed on the lower right side of the LCD. Signal strength is measured at the BNC and is independent of the gain setting.

ON/OFF Switch turns M-331 on/off.

BATTERY One 9 volt, transistor type, alkaline battery required. Battery level is displayed on the LCD at turn on.

FILTER This switch enables a digital filter to minimize the audio noise from non 60 Hz RFI such as ignition noise. It does not impact the bar graph.

FREQUENCY (FREQ.) This knob is used to select the desired frequency within the tuning band of approximately 320 to 340 MHz.

VOLUME Volume is controlled with a High-Low slide switch.

RF GAIN This control sets the desired sensitivity. The level selected appears briefly on the left side of the LCD whenever the gain is changed.

AUDIO JACK Used in noisy areas to listen to RFI through headphones that have an impedance of 16 ohms and a 1/8" stereo plug jack.

SPEAKER Two inch Mylar speaker faces the operator.

ANTENNA The antenna provided with this instrument is a four element Yagi antenna. It is designed for maximum sensitivity between 320 and 340 MHz. It is very directional and has a good front to back ratio. The antenna handle is designed so that it can be moved along the antenna boom to accommodate different arm lengths and can be rotated for storage in the carrying case. To loosen the handle, rotate it in a counter-clockwise direction.

IV LOCATING WITH THE MODEL M-331

A. THEORY

A single sparking source can generate RF interference over a very broad frequency range, from below 1.0 MHz to above 1000 MHz. The lower frequencies can propagate down a power line for great distances from the source-pole. At 1 MHz in the AM band it is not unusual for a spark to be detected miles from its source. On the other hand the higher frequency component drops in level rapidly as it propagates down the power line.

Sparking noise detected in the range of 320-340 MHz usually indicates that the source is within four or five poles. Comparative noise-level readings between the poles will lead the user to the source-pole (or “structure”). See also abbreviated field instructions at the front of this manual.

As a general proposition, most complaints are caused by distribution line sparking sources. However, the basic theory applies to both distribution and transmission lines.

B. OPERATION

1. Analyze:

A. Before beginning your search, verify with your customer that the source which is causing the problem is actually "on" or present. Spark gap noise sources can be intermittent.

B. In House Locating:
Up to 50% of all RFI originates indoors. Examples include switching power supplies, variable speed drives, light dimmers, compact florescent lights, LEDs, Doorbell transformers and fish tank heaters. Your search should begin at the customer's home or office. If you can turn off the main circuit breaker that is often the most effective way to rule out an indoor source in the customers' home, before searching on the power lines.
The Model M-331 can be used indoors but its performance may be degraded. House wiring can act like multiple antennas and yield confusing information. Also, most electronic sources are low frequency (below 100MHz) and are not detectable by the M-331 at 300+ MHz. The Radar Engineers Inc Model 245 Circuit Sniffer is a good tool to use indoors for both sparking and electronic sources.

2. Start Up:

A. Turn on the instrument.

B. Set Frequency control initially at the twelve o'clock position. The instrument can be tuned to receive any sparking noise or any transmitted signal in the ballpark of approximately 320 to 340 MHz. This band is relatively quiet. It has been assigned to the

C. Coast Guard, to airport landing systems, and to government mobile operations. Such stations have low-power output as compared to commercial (AM, FM and TV) broadcast stations, and you won't pick up these low-power stations unless you are near a transmitter. In the event you do detect a broadcast transmission tune away from it so you can have "dead space" to listen for power line sparking.

D. Set Gain on Maximum to Start. Decrease the gain setting if the bar graph reading is above 10.

E. Detect Pole with Spark. With the antenna directed at a power pole observe the bar graph deflection on the LCD and listen for the characteristic "static" or "bacon frying" of a spark.

In some cases it may help to 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.

F. Make Comparative Readings to I.D. the Source Pole: Once a source is detected the exact structure from which the arcing originates needs to be determined. One feature of RFI is that it is transmitted through the air and propagated along the conductor. In fact the power line acts like a big antenna. As the RFI propagates along the conductor a reflection of the signal usually occurs at poles adjacent to or near the actual source pole. That is called reradiated interference. To distinguish the actual source from the reradiated reflection stand across the street and halfway between the suspect poles. Do not make comparative readings while standing under the pole line. Point the antenna at one pole and then the other. Take comparative signal level readings.

Walk in the direction of the pole with the strongest signal. Still 30-50 feet from the powerline and standing halfway between the next two poles make another signal level comparison. Continue the process until the strongest received signal is on the pole you walked past. That is the likely source.

G. Pinpoint the sparking hardware. The Model M-331 cannot pinpoint sparking hardware. Instead use Radar Engineers' Model 247B Hotstick Line Sniffer or Model 251 Parabolic Pinpointer. They can identify the specific device on the pole that is sparking and causing RFI.

H. Try to be on hand when corrective work is being done and monitor the work. You will be able to tell immediately with the M-331 that the corrective work has solved the problem.

3. Misc.:

A. Multiple Sources: It is not uncommon to encounter more than one source of RFI. When this happens first locate the source with the highest signal strength reading. It is likely to be the source bothering your customer.

B. 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 detect RFI. To verify that a noise is not being picked up off a side or back lobe, decrease your RF gain until you can detect the source when pointed in only one direction.

C. Preventive Maintenance: Sparks can be an indication of a maintenance problem. More and more utilities are using the M-331 to identify arcing hot clamps, cracked/arcing bushings and bad

lightning arrestors etc. One characteristic these types of sources have in common is they are attached to the primary and usually have a very high signal levels, unlike loose hardware.

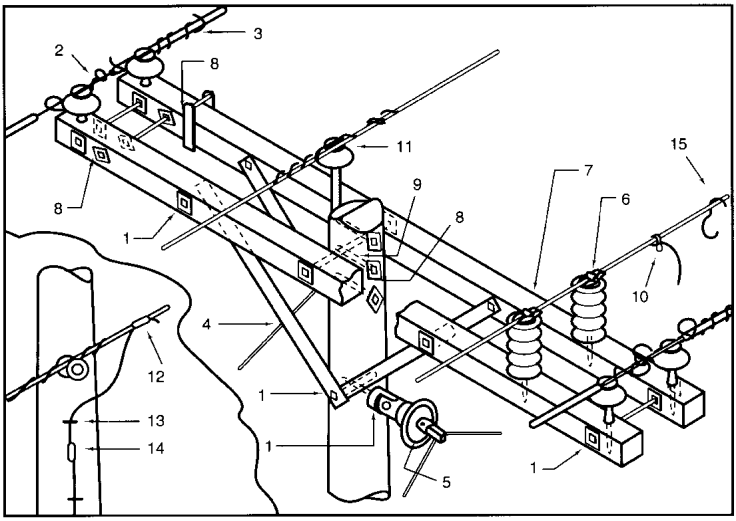
V SPARKING ON POWER LINES

A. Sources

Power line interference sources are sparks or in some cases arcs. They are often found at a loose or corroded connection between two pieces of hardware. When two pieces of metal are not making good contact they become charged to different voltage levels, and if this difference becomes large enough a spark will bridge the gap. The spark will tend to equalize the voltages and will then self-extinguish.

This allows the voltage difference to build up again until another spark jumps across the gap. This process will repeat one or many times during each voltage cycle of the 60 Hz power line. It is not necessary to have high voltage between the two pieces of metal. If the gap is very small a spark and RFI may be created with less than 100 volts.

Typical power line sources:



Possible sparking sites on distribution structures:

1. Loose Hardware
2. Loose Tie-Wire on Conductor
3. Loose Tie-Wire on Insulated Conductor
4. Guy Wire Touching Cross-Arm Brace
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

B. FREQUENCY

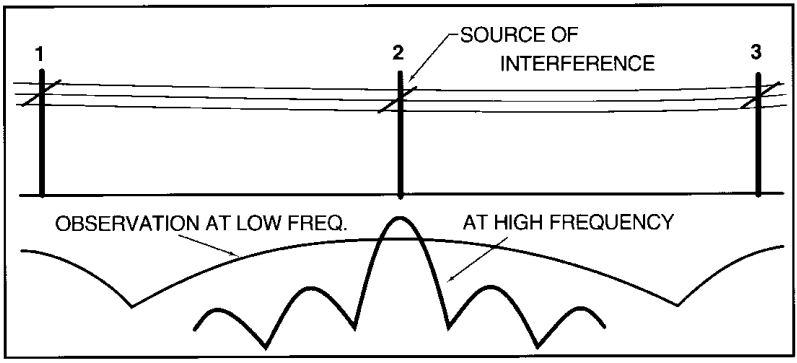
Unlike a radio or TV transmitter which operates at a specific frequency, a sparking RFI source is usually “broadband”, that is, it typically generates electromagnetic energy waves over a wide range of frequencies between 1 KHz and 1 GHz. As a consequence a sparking source can usually be detected anywhere between 1 KHz and 1 GHz, provided that you are close enough to it. As a general rule the lower frequencies can propagate for miles while the higher frequencies drop rapidly with distance from the source.

RF energy from a spark propagates on the conductor

RFI also radiates through the air. The air is a less efficient medium for spark RF transmission. So as you move away from a power line the signal level drops very quickly at all frequencies.

The M-331 takes advantage of these characteristics and is tunable only between about 320 – 340 MHz. So you must be within a few poles of a source to detect it.

The radiation of noise frequencies from a pole line is shown below, 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 will radiate a long distance while the higher frequency exists (and can be detected) only near the source.



Low and High Noise Frequencies observed along Line from Single Source

For a thorough discussion of the nature of RFI and how to locate it, please refer to “AC Power Interference Handbook” by Marv Loftness.

C. FACTORS AFFECTING RFI

1. 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, sparking will not ordinarily reappear until the moisture has evaporated.

   Similarly, nighttime dew usually shorts out spark gaps and turns the sources off until the sun comes out and burns the dew off.

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

3. Contamination
   Salt and other contaminants in coastal and industrial areas can adhere to insulator surfaces. When wet these contaminants create a path for current to flow and cause tracking. Gaps in the current path act like spark gaps, and create RFI.

4. Enclosed Sources
   Sparking that occurs inside a shielded 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 higher frequency (UHF) output from the source is usually quite weak and may not be detected by the Model M-331. The Model 247B could be tried instead since it operates at lower frequencies.

5. Corona Sources
   Corona is sometimes referred to as point discharge. The discharge off the end of a sharp object at very high voltage is an example of corona. Sparking is, on the other hand, a complete discharge across a very small gap. The difference between corona (point discharge) and sparking (gap discharge) is significant. Corona does not usually occur on distribution lines, except at times at the end of tie wires. Corona is common on transmission lines. However corona usually does not cause the interference utility customers complain about. The reason is that corona is typically weak and usually does not radiate more than a block or two.

VI WARRANTY AND NOTICE TO PURCHASER

All products manufactured by Radar Engineers Inc 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 LIEU OF ANY OTHER WARRANTY, EXPRESSED OR IMPLIED, INCLUDING BUT NOT LIMITED TO, ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS 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 statements, 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 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 officers of seller and manufacturer.

VII REPAIRS AND CUSTOMER SERVICE

Radar Engineers Inc 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 NE Colfax Street
Portland OR 97220

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

If you have any questions regarding the operation of this instrument, call Radar Engineers Inc at: 503-256-3417