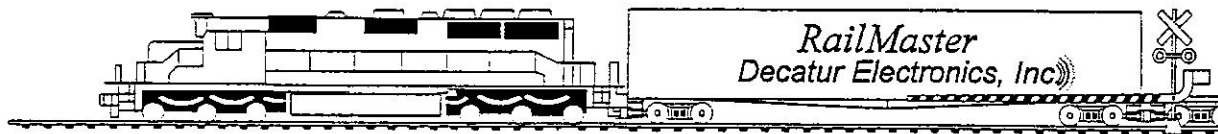


Decatur Electronics, Inc.



RailMaster

User's and Installation Manual



715 Bright Street • Decatur, Illinois 62522 • (800) 428-4315 • FAX: (217) 428-5302
Revised May 11, 1995

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0 Specifications

0.1 Antenna Parameters

K-Band

Transmission Frequency	24.150 GHz
Horizontal Beamwidth	12°
Polarization	Circular
Nominal Microwave Power Output	8 mW minimum 15 mW typical 22 mW maximum
Maximum Aperture Power Density	$\leq 1 \text{ mW/cm}^2$

Environment

Ambient Operating Temperatures	-30°C to +60°C
Ambient Storage Temperatures	-30°C to +85°C
Maximum Humidity	90% relative humidity at 37°C

NOTE: The RailMaster complies with part 15 of the FCC rules. Any changes or modifications to the device, without prior approval of Decatur Electronics, Inc., could void the user's license to operate the RailMaster.

0.2 Speed Ranges

Speed Display Ranges	Minimum	Maximum
Low Speed Mode: mph Option	1.0	20.0
kph Option	1.6	32.1
High Speed Mode: mph Option	10	100
kph Option	16	160

0.3 Power Requirements

Supply Voltage Range	10.8 to 16.5 VDC with a 2A Fast Blow Fuse
Low Voltage Threshold	10.8 VDC with Visual Indicator

Nominal Current Draw with a Supply Voltage of 13.6 VDC	Current Draw
Backlit Display with no Power	0.06
Powered Unit, in HOLD Mode	0.21
Powered Unit, in XMIT Mode	0.39

Current Requirements for the RailMaster, in Amperes

1 Controls

The RailMaster has five (5) tactile buttons and a trigger on the pistol grip. When pressing a button on the control panel, the switches make a slight "click" sound when fully depressed.

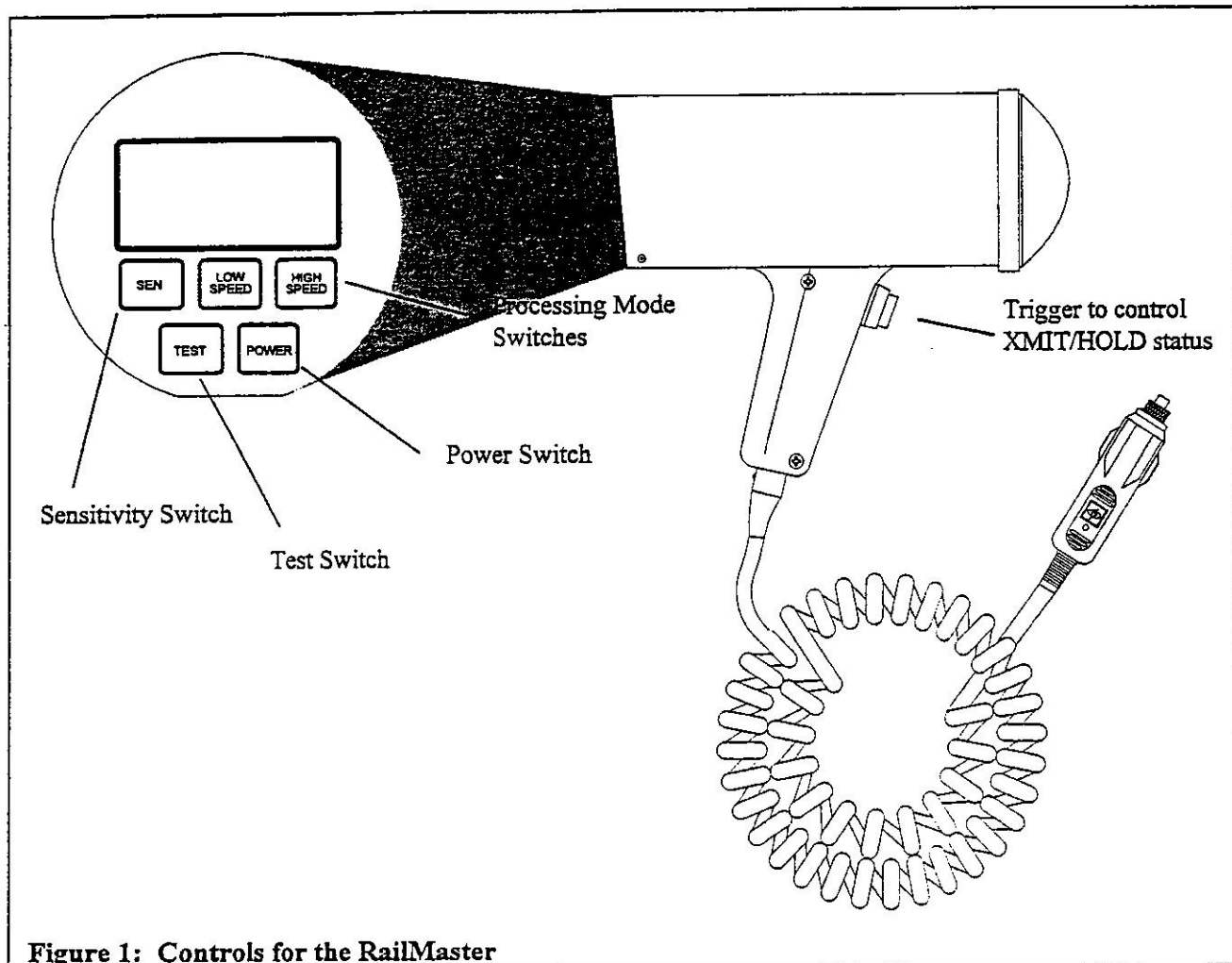


Figure 1: Controls for the RailMaster

1.1 Front Panel

POWER

The POWER button turns the RailMaster unit on and off. When depressed, the unit illuminates all of the LCD segments to verify that the display is working properly. The unit, upon power-up, is in LOW SPEED mode, with a sensitivity setting of nine (see below).

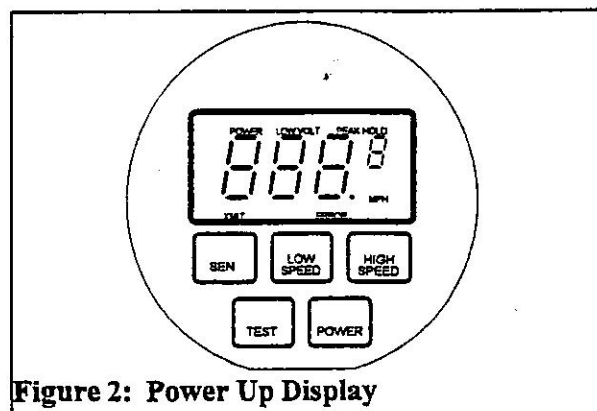


Figure 2: Power Up Display

SEN

The SEN settings reflect the relative sensitivity and detection range of the RADAR, in ten steps.

When the SEN button is pressed, the computer displays, for two (2) seconds, the word "SEN" and a number between zero (0) and nine (9). If the SEN button is pressed and held, the display will count from nine (9) to zero (0), and begin counting at nine (9) again.

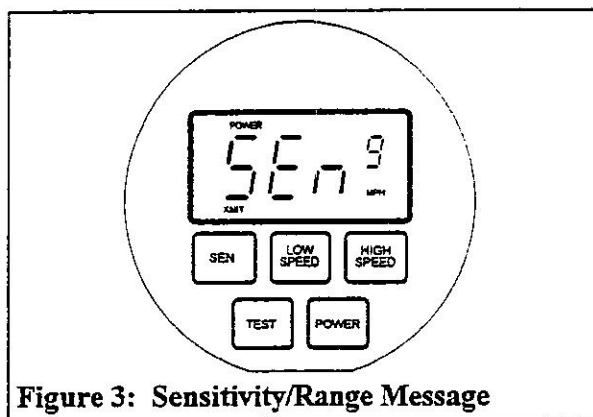


Figure 3: Sensitivity/Range Message

LOW SPEED

When this mode is selected, the computer displays, in succession, the words "Lo" and "SPd" on the LCD display. The decimal point will also light up. While in LOW SPEED mode, the system will read speeds to the nearest tenth of the speed option desired. Also, when the system is in LOW SPEED mode, the system is capable of reading a person walking. Therefore, DO NOT MOVE THE UNIT WHILE TAKING SPEED MEASUREMENTS. THE READINGS WILL INCORPORATE THE OPERATOR'S WALKING SPEED.

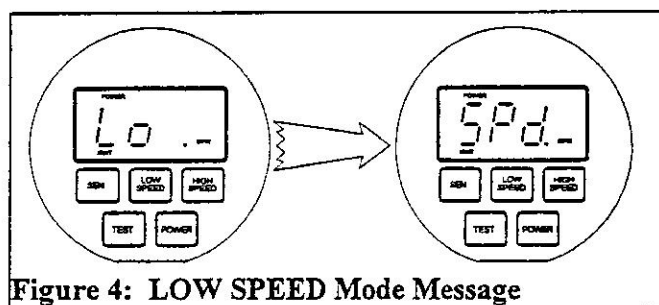


Figure 4: LOW SPEED Mode Message

The especially sensitive nature of the RailMaster, in LOW SPEED mode, allows the user to inadvertently measure the speeds of rain, blown dust and mist, insects, and birds. With proper usage, the system preferentially displays the speed for a locomotive. However, when there is no visible target, and the RADAR is transmitting, there is a possibility of detecting small objects (see Section 5.4).

HIGH SPEED

When this mode is selected, the RailMaster displays the words "Hi" and "SPd" on the LCD display. The decimal point will turn off at this time. While in HIGH SPEED mode, the system will read speeds to the nearest ones place.

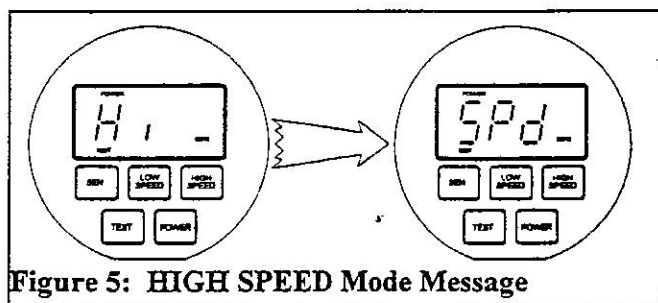


Figure 5: HIGH SPEED Mode Message

TEST

The computer initiates a self test of the display and processing circuitry. If an error is found, an appropriate error indicator will activate. See Section 4 for details on the test sequence.

1.2 Trigger

The spring loaded trigger for the RailMaster controls the transmission of the RADAR signal and the speed lock feature.

To transmit the RADAR signal, press and release the trigger once. The trigger button will remain in the depressed position when released. Also, the XMIT indicator will light. When the trigger is pressed and released a second time, the computer stops transmitting the RADAR signal. The HOLD indicator will light. If there was a speed on the display, changing to HOLD mode will lock the speed onto the screen. A locked speed flashes until the user clears the display.

To clear a locked speed,

- Depress the trigger again, setting the system in XMIT mode
- Turn the system off (this method is not recommended)

NOTE: THE MICROWAVE TRANSMITTER CONSUMES ROUGHLY HALF OF THE POWER FROM THE BATTERY. KEEPING THE SYSTEM IN HOLD MODE WHEN NOT READING EVENTS WILL GREATLY EXTEND THE LIFE OF THE BATTERY.

2 LCD Display

The RailMaster uses a backlit LCD display. The backlight is on even when the system is not active. While the backlight draws little power, it is recommended that the system be unplugged from the battery pack when the unit will be stored for extended periods of time.

2.1 Speed Window

The speed portion of the LCD display consists of three (3) large digits, a decimal point, and a smaller digit. Typically, the digits displays the speed of an event. The speed window also displays messages.

Error Messages

There are three error messages for the RailMaster. While any of the error messages are displayed, the computer suspends operation.

Radio Frequency Interference

The RailMaster receives various kinds of signals. Occasionally, signals from transmitting radios, cellular phones, laptop computers, etc. will interfere with the operation of the RailMaster (see Section 5.1). When the interference becomes excessive, the system will display "rFI". The ERROR indicator will also be active. While the interference is present, the system will not process speeds. Once the interference ends, the computer will resume normal operation.

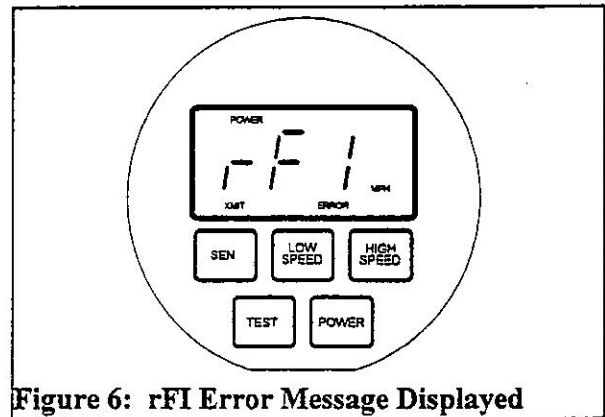


Figure 6: rFI Error Message Displayed

Low Voltage Error

If the battery power is insufficient, the system displays "bAt" on the large digits. The LOW VOLT indicator will also be active. Until the voltage for the unit is adequate, the system will not process any speeds. Check the plug to make sure that it is firmly inserted into the power receptacle. Typically, with battery packs, this error indicates that the battery needs recharging.

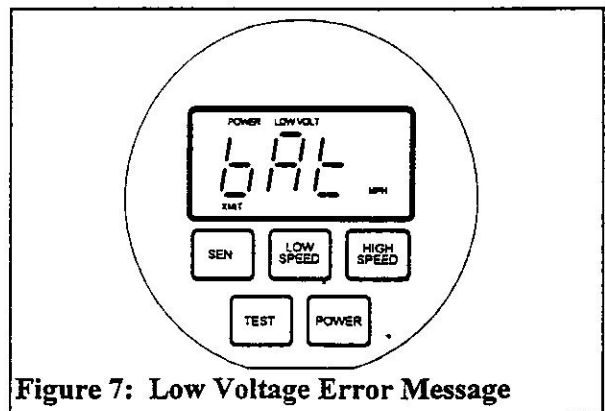


Figure 7: Low Voltage Error Message

System Error

The computer, after performing the initializing test, will activate the ERROR indicator if there was a problem found with the internal components.

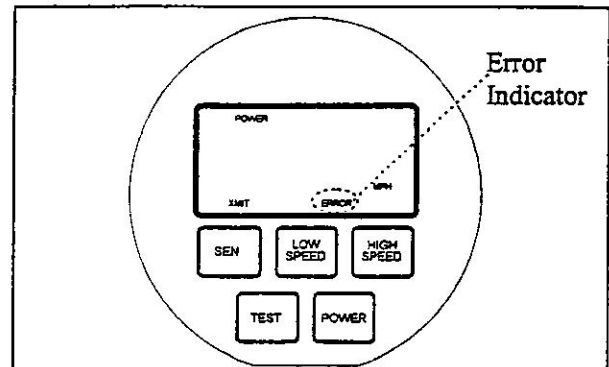


Figure 8: System Error Message

2.2 Indicators

In addition to the digits, there are eight (8) text indicators

- **POWER** - This indicator remains active while the unit is on.
- **LOW VOLT** - This indicator is lit when the power supply voltage is not adequate for proper operation.
- **PEAK HOLD** - This indicator is active for the self test only and is reserved for future development.
- **XMIT** - The computer uses this indicator to inform the user when the RADAR is transmitting.
- **HOLD** - This indicator is lit when the RADAR is not transmitting.
- **ERROR** - The indicator is lit when an internal error has been found.
- **MPH, KPH, KNOTS** - Only one of these indicators are lit to inform the user of the measurement units of the speed displayed.

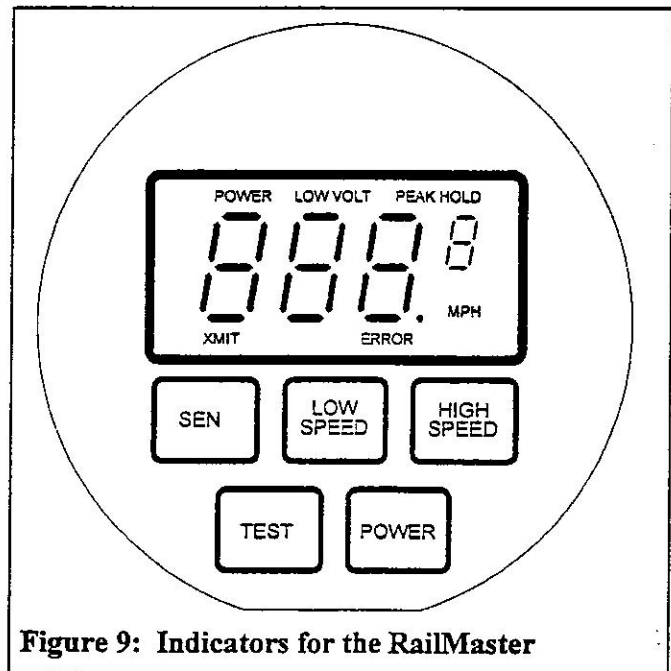


Figure 9: Indicators for the RailMaster

3 Field Tests

There are three tests, to verify the accuracy of the RailMaster system.

3.1 Initializing Test

When the system is initially activated, the computer runs an internal diagnostic. Then, all of the indicators and digits of the LCD display are lit. If the computer finds an internal problem (thereby activating the ERROR indicator) or any of the indicators do not activate, have a qualified, Decatur Electronics technician service the unit.

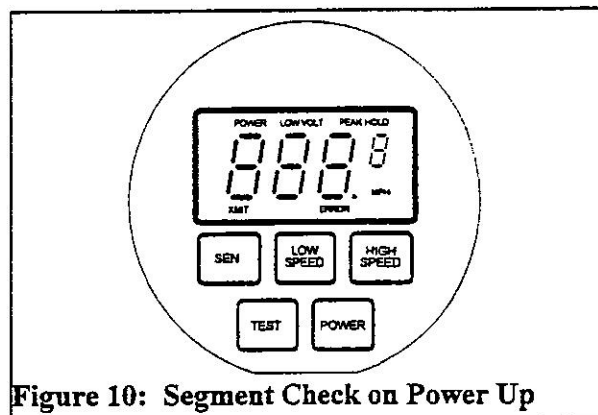


Figure 10: Segment Check on Power Up

3.2 Operator TEST

The TEST button initiates this field test. During the operator TEST, the computer performs the following steps.

- The "ones", "tens", and "hundreds" places, of the display, count from one (1) to eight (8).
- The computer activates all of the segments and the text indicators. The user verifies that the display works correctly.
- The computer tests the accuracy of the speed processing system by simulating the speeds 15, 30, 45, and 60 mph (25, 50, 75, and 100 kph). As each speed is processed, the system displays the speed on the LCD display.

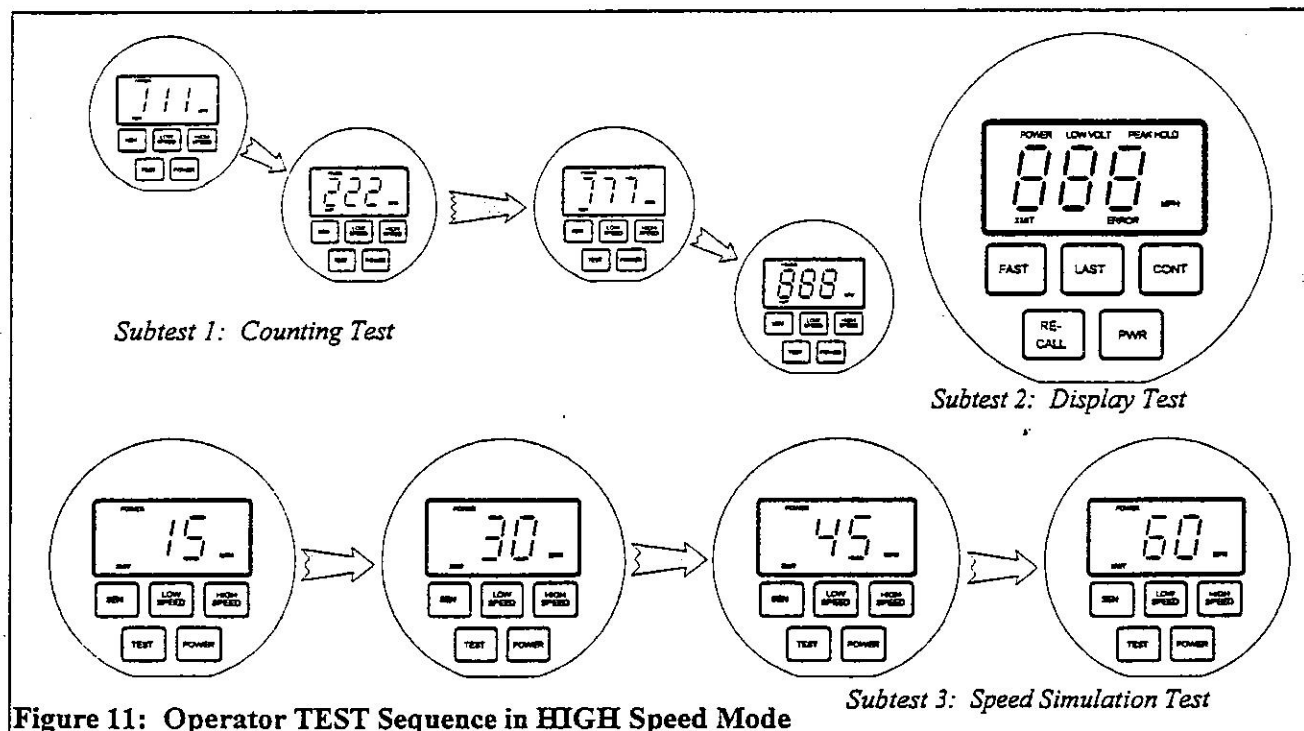


Figure 11: Operator TEST Sequence in HIGH Speed Mode

- If the computer detects an error while processing the speeds, the appropriate ERROR indicator will light, and the system will not process speeds until serviced.

3.3 Tuning Fork Test

In addition to the other tests, the operator can verify the overall system accuracy by using a tuning fork.

After tapping one of the tines of a tuning fork, the fork vibrates at the frequency stamped on the handle. When the operator places the tuning fork in front of the antenna, the system detects the fork and displays a speed. Then, compare the speed displayed to the speed stamped on the fork.

Tapping the tines against surfaces like metal and concrete MAY DAMAGE THE TINES AND INVALIDATE THE FORK FOR FUTURE TESTS. Tap the tines against hard plastic or wood. Using the fork in extremes of temperature may also affect the readings.

The tuning fork test consists of the following steps.

- Grasp the tuning fork by the handle and tap one of the tines against a firm surface.
- Hold the vibrating tuning fork approximately three (3) inches from the front of the antenna.
- Verify that the speed in the window and speed marked on the tuning fork are the same. Typically, the difference between the speed marked on the fork and displayed by the unit are due to temperature and tiny imperfections over the life of the fork. If there is a significant difference between the display and the fork, check the tuning fork for damage. Repeat the procedure with another, certified tuning fork. If there is still an error of more than 0.6 mph, have the unit repaired by a qualified, Decatur Electronics technician.

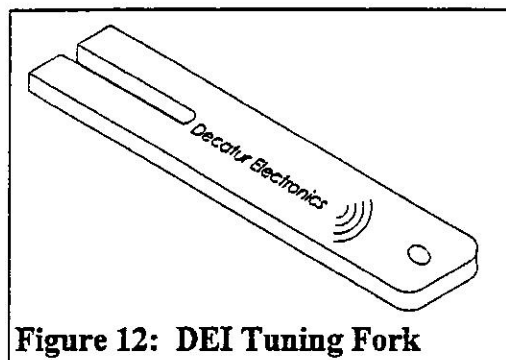


Figure 12: DEI Tuning Fork

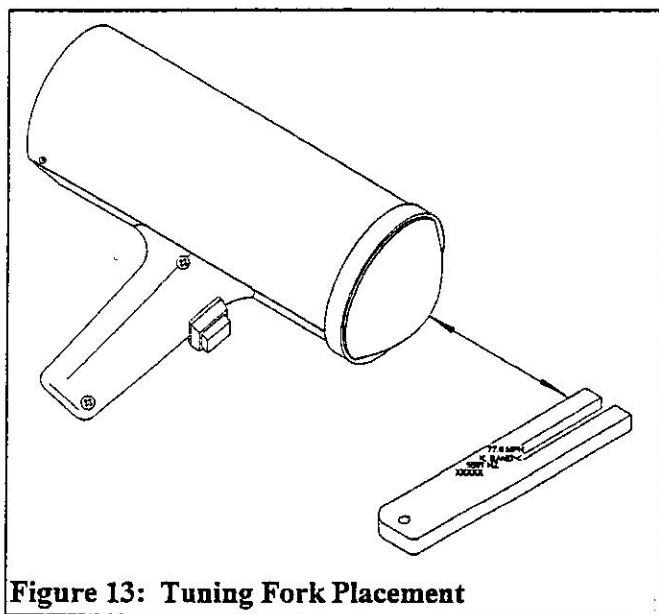


Figure 13: Tuning Fork Placement

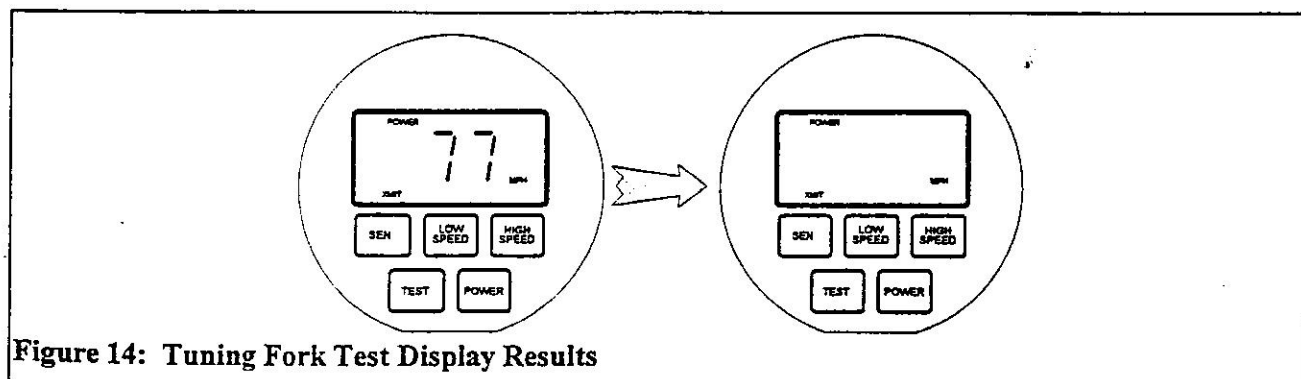


Figure 14: Tuning Fork Test Display Results

4 Care, Cleaning, and Storage

The RailMaster can withstand wide variations in temperature. DO NOT SPILL FOOD, BEVERAGES, OR OTHER LIQUIDS AND SUBSTANCES ON THE SYSTEM.

When the RailMaster is not in use, store the unit in the original packaging. Also store the unit in the original packaging during transportation.

To clean the components, dust them lightly with a soft, clean cloth - free of any cleaning solutions.

5 Limitations to Doppler RADAR

With properly used, the Doppler RADAR system has been proven to be extremely accurate and reliable. However, the variations in the environment can cause situations and circumstances which may create speeds that appear incorrect

5.1 Angular Errors

Whenever the RADAR and the target are at an angle to each other, there is a slight error due to the angle between the two.

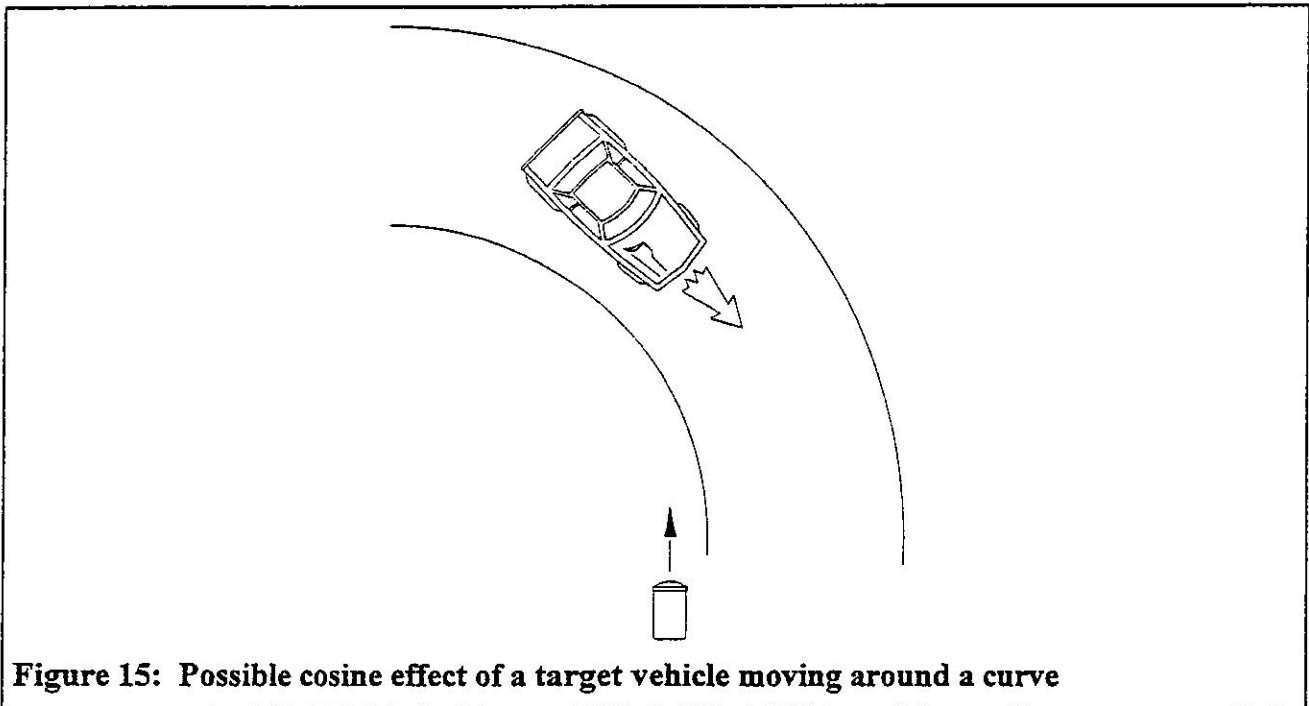


Figure 15: Possible cosine effect of a target vehicle moving around a curve

Whenever the angle between the front of the antenna and the target increases, the displayed speed decreases. Ideally, an angle of zero (0) degrees are preferable, since the displayed speed will be the actual target speed. The following table shows the effects that an increasing angle can have on the speed displayed.

Actual Speed	Angle, in degrees										
	0	1	3	5	10	15	20	30	45	60	90
10.0 mph	10.0	9.9	9.9	9.9	9.8	9.6	9.3	8.6	7.0	5.0	0.0
20.0 mph	20.0	19.9	19.9	19.9	19.6	19.3	18.7	17.3	14.1	10.0	0.0
30 mph	30	29	29	29	29	28	28	26	21	15	0
40 mph	40	39	39	39	39	38	37	34	28	20	0
50 mph	50	49	49	49	49	48	46	43	35	25	0
60 mph	60	59	59	59	59	57	56	51	31	30	0
70 mph	70	69	69	69	68	67	65	60	49	35	0
80 mph	80	79	79	79	78	77	75	69	57	40	0

Table 1: Actual and Displayed Speeds at Different Antenna-to-Target Angles

At angles less than 10°, the difference between the target and actual speed is small. As the angle increases, the error increases, until, at 90°, the TARGET speed is zero mph-grossly incorrect.

5.2 Radio Frequency Interference

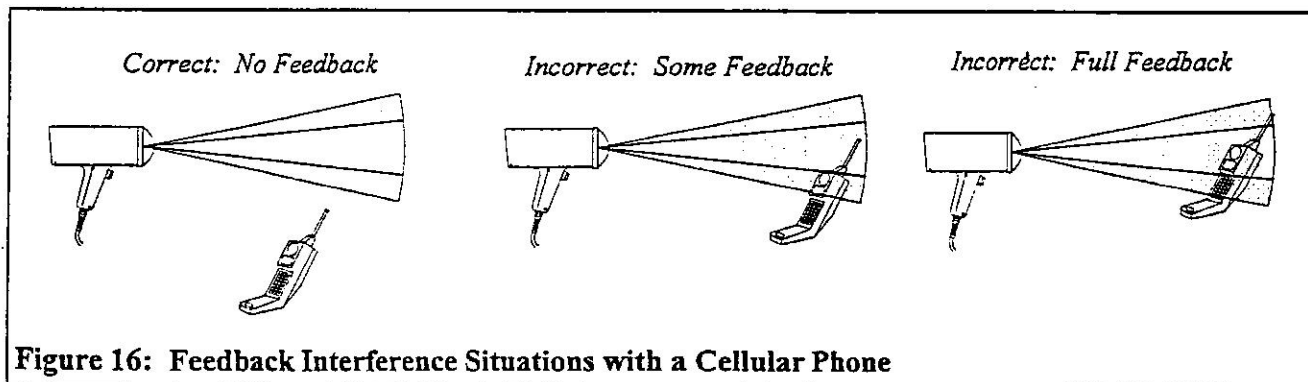
RADAR systems, like any other radio system, are subject to external interference. There are many kinds of interference.

The system may inadvertently process radio frequency energy from airport RADAR, CB radio transmitters, cellular phones, laptop computers, and AM/FM transmission towers as Doppler speeds. The ProSpeed DSP has a radio frequency interference (RFI) detection circuit, designed to detect excess radio frequency energy. When stray radio frequency energy reaches an excessive level, the "rFI" indicator will activate, and no speeds will be displayed.

Once the source of radio interference ends, the system will resume normal operation.

5.3 Feedback Interference

Whenever the RADAR is directed at TV screens, lights, or electronics, the RADAR may detect erroneous speeds. Typically, this form of noise is noticeable when the speed displayed is inconsistent with the perceived event. To remedy this problem, turn the RADAR off then back on. If the problem persists, relocate the RADAR in a way to minimize the effect of the source of interference.



5.4 Moving Objects

The RailMaster, like any RADAR system, detects a wide range of objects. The larger the object, the easier the system can "see" the target. However, when a large target, like a locomotive engine, is not present, the RailMaster can "see" smaller objects. The LOW SPEED mode of the RailMaster is sensitive enough to detect the speeds of light rain, insects, birds, and walking people (see Section 1.1). When the computer is "seeing" a small object, the speeds displayed are erratic. When a larger target moves in front of the RADAR, the system will display the speed of the locomotive instead of smaller targets. Therefore, when the system displays speeds for no obvious target, direct the RADAR at a large moving object or perform one of the tests described in Section 3 to verify proper operation.

6 Sign and Computer Interfacing

6.1 Visimax Signs

The RailMaster has been designed to interface with the Visimax Pro (3 digit) or Visimax Sport (2 digit) external speed signs. To connect the RADAR to a sign, detach the power cord and connect the communications cable to the power cord socket in the pistol grip.

To interface to the Visimax 9000 sign, please contact your sales representative for the software upgrade needed.

6.2 Other Signs

The RailMaster does not interface to non-Visimax signs.

CONNECTING THE SYSTEM TO A SIGN NOT ENDORSED BY DECATUR ELECTRONICS MAY RESULT IN PERMANENT DAMAGE AND MAY INVALIDATE THE WARRANTY.

If there is a question about the compatibility of a sign with the ProSpeed DSP, contact your sales representative for more information.

6.3 Personal Computers

The RailMaster can interface with a personal computer. An RS-232 converter for the RailMaster is required to connect the RADAR to the PC. Contact your sales representative for details about the RS-232 adapter. The RS-232 adapter is provided with an instruction booklet detailing connections and communications protocols and commands.

7 Warranty

7.1 Terms

TWO YEAR RADAR WARRANTY

Decatur Electronics, Inc. guarantees their RADAR to be free from defects in workmanship and material, and to operate within specifications for a period of two years. During this period, Decatur Electronics, Inc. will repair or replace, at its option, any component found to be defective, without cost to the owner, provided the unit is returned to the factory.

The full warranty on parts and workmanship does not include normal wear and tear, crushing, dropping, fire, impact, immersion, or damage from attempted repair by unauthorized service agents, or improper voltage and fusing.

Simply return the unit (transportation prepaid) directly to the factory or to an Authorized Decatur Electronics Warranty Service Center near you.

If you have any questions, or want a quick problem diagnosis, please call our customer service department:

phone: (217) 428-4315

fax: (217) 428-5302

EXTENDED WARRANTY OPTIONS

If you are interested in an extended warranty, contact your sales representative to discuss extended warranty options.

7.2 Service Return Procedure

If it becomes necessary to return the RailMaster unit to the factory, please follow the procedure below:

- Telephone the Customer Service Department, at Decatur Electronics: 1-800-428-4315, to obtain a return authorization (RA) number. Write the RA number on the note and shipping label.
- ALL pieces of the RailMaster should be returned in the original packaging.
- Include a note describing the malfunction of the system, or the incident that resulted in a malfunction. Failure to do so may delay the return of the system.
- Return the system, via UPS, to:

DECATUR ELECTRONICS, INC.

715 BRIGHT STREET

DECATUR, IL 62522

RA#: xxxxxxx

Decatur Electronics, Inc. will pay for return freight (up to \$10.00 US) for systems still under warranty. The system will be returned to the customer, via UPS or Air Parcel Post, with a \$10.00 shipping fee charged to the customers. If Express or Next Day Air is desired, the customer will be invoiced for the freight charges, even if the system is still under warranty.

If a system, still under warranty, is received COD from a customer, they will be charged for the amount of the COD freight charges plus an additional 10% for handling, after the system is repaired. The COD and 10% handling fee will be added to the repair bill as out-of-warranty repairs.

An estimate can be furnished for repairs that are out-of-warranty, at the customer's request, for \$50.00 US. Even if the customer decides to not have the repairs completed, they will be invoiced for the \$50.00, plus return freight. If Decatur Electronics proceeds with the repairs, there will be no charge for the estimate.

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