ZAON
FLIGHT SYSTEMS

pcas | Portable Collision Avoidance Systems

Owner's Manual

PCAS MRX
September 2008

Portable Collision Avoidance System™ (PCAS™)
Model MRX™ Owner's Manual

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Part number 2000-9101 Rev 9/08
Printed in the USA

Covers Firmware Version 2.9 and prior (1.9 for non-installed systems)

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Introduction

Thank You

Congratulations on your purchase of the Zaon MRX. This unit incorporates fourth-generation PCAS™ technology in a compact feature-filled unit. PCAS, or Portable Collision Avoidance System, is the technology developed exclusively by Zaon Flight Systems that makes this unit possible.

MRX offers many innovative features, and first-time users may encounter a slight learning curve. Every effort has been afforded to provide a concise manual with clear, comprehensive explanations of all features.

We are pleased to offer you the latest in avionics technology, designed for your personal protection. After reading the manual through, should you have any questions or concerns, we look forward to hearing from you.

Sincerely,

Zaon Flight Systems, Inc.
Avionics Research & Development

Please read through this manual in its entirety and completely familiarize yourself with MRX features before operating the unit.

Terminology

The following terminology is used in this manual, supporting and supplementary documentation, and throughout Zaon documentation and web-based media.

PCAS Portable Collision Avoidance System(s). Refers to the general technology developed to make collision avoidance portable. May include one or more specific models (ie: XRX and/or MRX, etc.). This technology was developed exclusively by Zaon Flight Systems.

MRX A specific model of PCAS technology with a specific set of abilities.

TCAS Traffic alert and Collision Avoidance System(s). Refers to the active traffic system used primarily by airliners. The system is independent of ATC or ground RADAR

Cautions & Warnings

As with all collision avoidance devices, MRX may not detect all aircraft within the detection window.

> MRX is not recommended as a substitute for proper traffic scanning procedures as listed in the FAA Airman's Information Manual and under the "See and Avoid" concept presented in FAA AC90-48C. This unit is intended as an additional tool in determining potential traffic threats.

> Until you are familiar with the operations and limitations of this unit, abrupt changes in the control of the aircraft should be avoided unless positive identification with the traffic is made, or you have been ordered to do so by the Air Traffic Controller. The FAA, their representatives, as well as published airspace regulations, always supersede any indication given by this unit.

> NEVER connect unit to an AC outlet. This may pose a fire hazard or result in an electric shock. NEVER connect the unit to a power source of more than 40V DC. Such a connection will harm the receiver and poses a fire hazard. NEVER connect a non-fused, external power source to the unit. This may result in damage to the unit and may pose a fire hazard. DO NOT connect the unit to any power source using reverse polarity. Doing so may also damage the unit. Follow the guidelines in this manual explicitly when connecting to an external power source.

> NEVER expose the unit to rain, snow or any liquid. Avoid placing the receiver in excessively dusty, hot, or cold environments. DO NOT use or place unit in areas with temperatures below -20°C (-4°F) or above +55°C (130°F).

> AVOID the use of chemical agents such as benzene or alcohol when cleaning, as they damage the unit surfaces.

> We highly recommend removing batteries from the unit when not in operation for extended periods of time. Even with the unit power OFF, a negligible current still flows through the circuitry. Fully charged batteries may experience a minute power drain that, over time, could deplete the batteries while the unit is powered OFF.

Manual/Unit Differences

Illustrations: The photos and illustrations in this manual may vary slightly from your unit. These differences are aesthetic only and should not change the functionality of your unit. From time to time, slight modifications are made for any number of reasons, and Zaon reserves the right to make these modifications without prior notification to customers.

Manual: The information contained in this manual, including numbers and figures, are subject to change without prior notice.

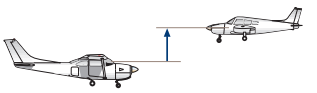
The latest manual will be available online at **www.zaon.aero** for downloading if revisions are issued. Refer to the version numbers inside the front cover of this manual.

Setup

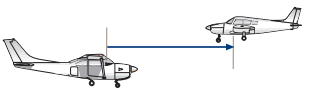
Step-by-Step

MRX At-A-Glance

- Digital range, scalable from 5NM to 1NM in 0.1 NM increments
- Tracks multiple aircraft
- Relative altitude, scalable from ±5000 ft to ±500 ft, with ascending/descending indicator
- A built-in altimeter for the highest, real-time accuracy available
- Displays the local squawk code and altitude
- On-screen and audio alerts for threats and advisories with volume control in front, quick mute button. No audio cables are needed.
- Accepts two "AA" batteries or aircraft power (10 - 40 VDC)
- Smallest size available (2.61" x 0.73" x 4.33")
- Menu-operated user interface with five-position navigation switch for easy operation
- Precise brightness control
- Accepts TCAS replies for rural use
- Auto Mode to reduce ground clutter



relative altitude + trend



digital range

Unpacking

Your MRX system contains everything you need for basic operation right out of the box. If any listed items are missing, please contact Zaon directly for replacement (see Appendix C: Customer Service).

	Description	Page
A >	PCAS MRX unit	–
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E >	Velcro® Mounting Dots (4)	–
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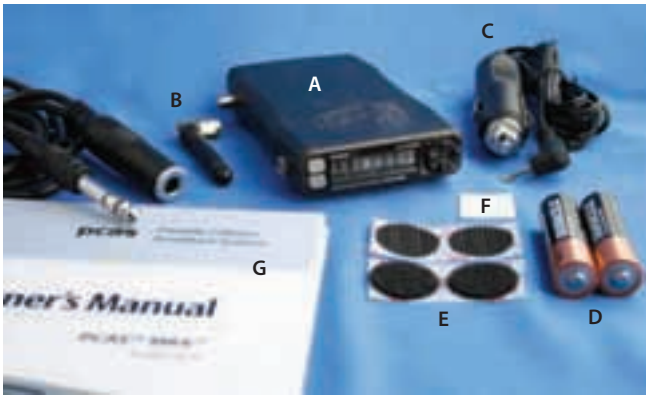


Setup

Placement Considerations

The preferred placement for MRX is on the glare shield of your aircraft with the antenna angled vertically. This configuration affords MRX the best possible sensitivity and accuracy. **Position MRX at least 2" away from any magnetic compass** to avoid potential magnetic interference.

Silicone feet and Velcro® have been provided to aid in preventing the unit from slipping off the dash.

You may remotely mount the antenna using an optional **antenna extender** (shown here), which allows the antenna to be mounted on a side or rear window, and allows the unit to be placed anywhere in the cockpit, such as under the dash. Visit our website for more info.

Connecting the Power

Power (Batteries)

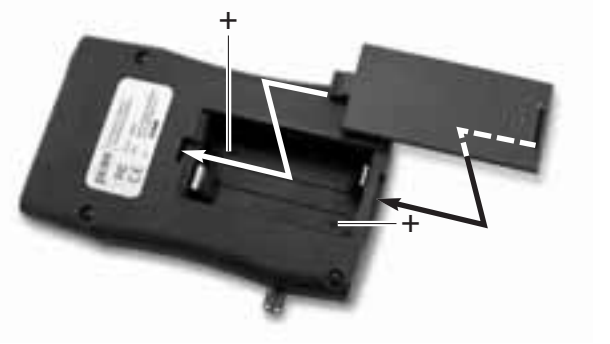
MRX can be powered from two AA batteries (included). Proper battery insertion must be observed. Improper battery insertion may result in damage to your unit, as well as battery leakage, and may pose a toxicity threat. Also, do not mix battery types (ie: alkalines and rechargeables).

Zaon recommends the use of Nickel-Metal-Hydride (NiMH) rechargeable batteries to achieve the longest battery life. A high mAh rating is recommended (typically 2000 or higher). Alkaline and other types of rechargeable batteries may be used, but you may experience a significant reduction in battery life duration. Setting the display brightness to maximum can reduce battery life by up to 25%.

To install batteries:

1 > Open battery bay door by pressing down on the door (use the lines for a better grip) and slide the cover towards the rear of the unit. Remove old batteries (if applicable) by gently tapping the unit from the top, with the battery bay facing down.

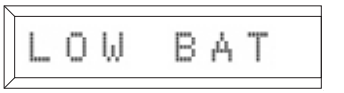
2 > Insert two new batteries, observing proper polarity. **Improper battery installation will damage your unit.**



3 > Place the battery bay door back on unit by inserting the tongue into the slot first and sliding the door towards the front until it clicks into place.

Low Battery Indication

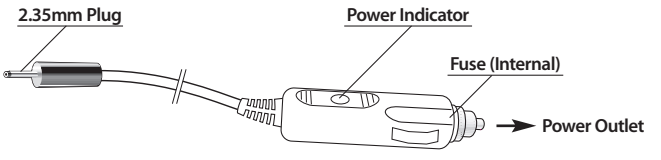
If using batteries, when the battery power drops below an acceptable level, MRX will issue one short beep, accompanied by a "LOW BAT" message for 2 seconds. This alert will continue every minute until the batteries are replaced or recharged.



If there is not enough power left in the batteries for proper operation, MRX will not start up. Replace the batteries to resume operation. A battery life indicator is also displayed during both the startup sequence and the local sequence.

For best performance, we recommend the use of Nickel-Metal-Hydride (NiMH) batteries. Alkaline batteries may be used, buty you may experience a significant reduction in battery life duration.

Power (External or Aircraft Power)



MRX may also be powered through your aircraft's "cigar-lighter" outlet*, using the included power adapter. The adapter provided with your unit incorporates a built-in replaceable fuse for safety, and can handle between 12-40 volts DC.

The adapter is sensitive to proper polarity, but just in case of improper polarity, MRX is protected against reverse polarity. The connector is tip-positive (+) and outside negative (-) and should only be used in negative-ground systems. Please consult your aircraft manual if you are unsure of your type of aircraft electrical system. **The power adapter does not charge the batteries.** No charging circuitry is contained in the power adapter or the MRX unit.

* Pilots flying newer Cessna models that do not have a cigar lighter outlet should call Zaon for alternative connections.

To replace the internal fuse:

1 > Disconnect both ends of the adapter

2 > Twist off the knurled end cap

3 > Replace the fuse with a 1- to 3-amp rated automobile-style quick-blow fuse

4 > Twist the knurled cap back into place

Connecting to Permanent/Hardwired Power

In some instances, you may wish to power the unit directly from the avionics bus or other power source. Hardwiring the power supply will require a dedicated 1.0 amp minimum, in-line fuse. An internal line filter suppresses any undue transient noise on the power supply. Also, be sure to follow any FAA requirements concerning installation guidelines.

Connecting the Antenna

To install the antenna:

1 > Position the right-angle antenna vertically at the antenna connector on the left side (from the front) of the MRX unit.

2 > Screw on the locking nut to secure the antenna. When the nut is properly secured, the antenna should not rotate.

3 > If the antenna is not straight up and down, unscrew the locking nut slightly and rotate the antenna vertically to position the antenna. When the antenna is vertical, retighten the nut.

4 > **Antenna must be snugly fastened to unit (finger tight).** If antenna is loose, you may notice a distinctive lack of traffic or the constant detection of an aircraft at the same altitude. In this case, the unit is detecting your own transponder. To solve this, tighten the antenna until significant resistance is met (finger tight).

It is imperative that the antenna be positioned vertically to receive the most accurate signal. Your MRX antenna is specifically tuned to receive an accurate signal when attached to your unit in the vertical position (either straight up or straight down). Orienting the antenna at any other angle will not accurately detect the signal because the amount of received power would be decreased, which is then translated into an inaccurate distance measure.

No other portable antennas are acceptable to deliver accurate traffic information.

It is imperative that the antenna be positioned vertically to receive the most accurate signal.

Controls and Functions

Description

1 > Power button

2 > Mute button

3 > Range (NM)

4 > Relative Altitude (±)

5 > Vertical Trend

6 > Mute Indicator

7 > Multi-function switch

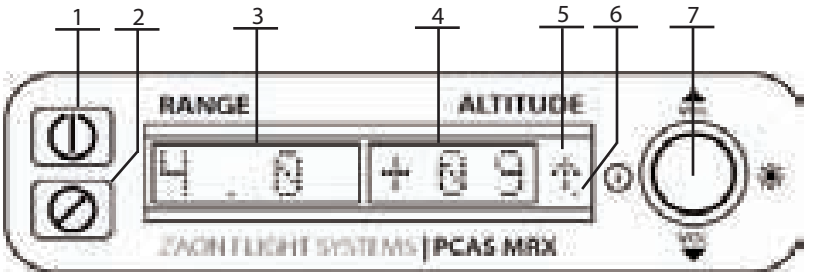
	Main	Menus
Up	Vol	Arrow Up
Down	Vol	Arrow Dn
Left	Local	Next
Right	Bright	Next
Push	Menu	Next

8 > Serial Number label

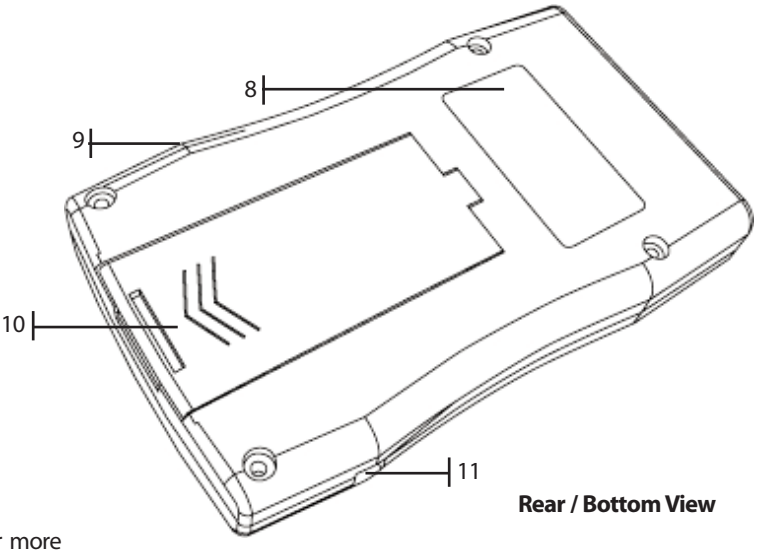
9 > Antenna connector

10 > Battery door

11 > Power connector



Front View



Rear / Bottom View

See "Buttons and Functions" chapter for more information on button operation.

Understanding PCAS

What is PCAS?

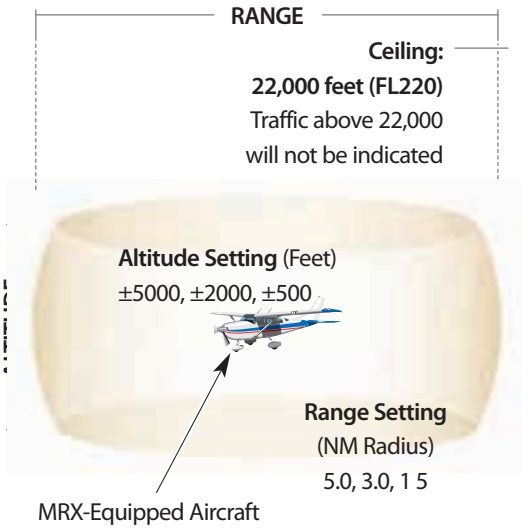
PCAS, which stands for Portable Collision Avoidance System, is a trademark of Zaon Flight Systems for technology similar in function to TCAS (Traffic and Collision Avoidance System). TCAS is the industry standard for commercial collision avoidance systems. The original PCAS technology was developed by Zaon in 1999. Now, the MRX/XRX line of collision avoidance systems incorporates the fourth generation of PCAS technology. Through this technology, transponder-equipped aircraft are detected and ranged, and the altitude is decoded. PCAS G4 technology has advanced to the point that highly accurate range, relative altitude, and quadrant direction* can be accurately detected in a portable, all-in-one cockpit device.

* Currently available on XRX model only.

What information does MRX give?

Reading your MRX is simple and straightforward if you understand the concepts behind its design and operation. MRX operation can be broken into two areas of thought and use: **traffic detection** and **traffic alerts**. It is important to know how to visualize the detection window around you.

The Detection Window



Illustrations not to scale

The MRX Detection Window is defined by two dimensions: vertical (altitude) and horizontal (range). This window surrounds your aircraft in flight and can best be visualized by imagining a "Bubble of Awareness" with your aircraft in the center.

The width of the bubble represents and is defined by range; the height is defined by altitude.

The width and height of the bubble can be reduced on one or both axis (see "Menus" later in this chapter).

In the illustration, the bubble represents the detection window.

By default, MRX is set to 5 NM and +/- 2000 feet at startup.

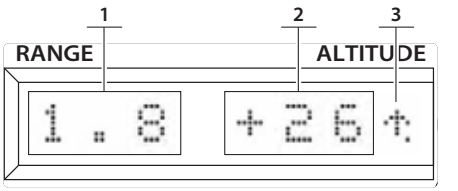
The Traffic Screen

Traffic is displayed in range and altitude relative to your local altitude (above you or below you, as indicated by + or -).

1 > Range in Nautical Miles

2 > Relative altitude above or below, in 100s of feet (FL)

3 > Vertical trend indicator



Altitude Indicators [2]		**Vertical Trend Indicators** [3]	
+	Above	↑	Climbing
- - -	Below	↓	Descending
00	Same Altitude		
No Indicator	Level or trend not available		

Other important things to know about the traffic screen:

> If **additional aircraft** are within the detection window, the aircraft displayed will represent the greatest threat. If another aircraft becomes a greater threat, the unit will switch the displayed information to reflect this new threat. See "Threat Switching" later in this section.

> "No traffic" is indicated by dashes only in both the range and altitude sections of the display.

Vertical Trend

In addition to relative altitude of the target aircraft, MRX also displays the vertical trend, or if the aircraft is climbing or ascending. Vertical trend is indicated by ↑ or ↓. Monitoring the vertical trend will assist in deciding if the aircraft is a threat or not. Traffic that is not climbing or descending will not indicate vertical trend. For example, an aircraft 300 feet above and descending is a much greater threat than if the aircraft is ascending.

Vertical trend is based on the target's actual altitude ascent/descent rate, not the relative altitude change rate.

Threat Prioritizing

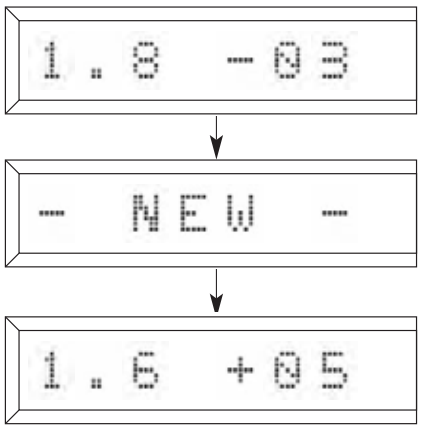
The primary aircraft is chosen by prioritizing using the following criteria:

> Threat aircraft relative altitude (vertical separation)

> Threat aircraft vertical trend (ascending or descending over time)

> Local aircraft vertical trend

> Range to target, if two or more aircraft match with regard to the above criteria



MRX tracks the most significant threat to your course of travel (the primary aircraft). Should MRX determine that a new aircraft has become a greater threat than the one currently being displayed, the unit will beep once and "–NEW–" will be displayed for two seconds, followed by the new aircraft information.

Following the rule that "accidents can only occur at your altitude", the aircraft with the least vertical separation, or where the relative altitude is less than any other, is determined to be the primary aircraft. However, vertical trend is also used to prioritize when two aircraft are on converging paths and both are within ±1000 feet. For example, if you are descending and another aircraft is below (within -1000 feet), it will be the primary threat, even if another aircraft is closer in range and/or relative altitude above you and level. See "Example Flight Scenarios" later in this chapter.

Resolution & Accuracy

With regard to the **range** of the target aircraft, accuracy increases exponentially the closer the threat gets to your MRX. Range can be determined by examining the amplitude of the received transponder signal and cross checking it against the other aircraft's altitude. For example, an aircraft 5,000 feet above you would not be less than 1.0 NM away. This helps ensure advisories issued are accurate given the true range to the other aircraft. Accuracy and resolution work hand-in-hand. For the MRX, traffic at a range greater than 2.0 miles is displayed in whole mile increments. Under 2.0 NM, the power output is far enough "up" the logarithmic scale that mileage can be accurately computed in 0.1 mile increments.

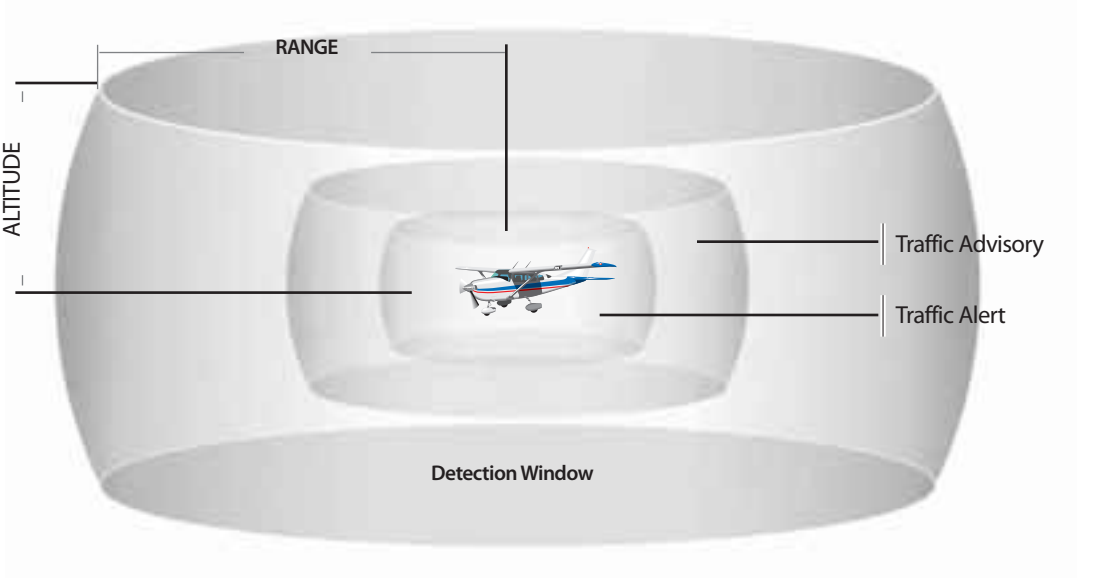
Altitude is set at 100-ft increments since this is the digital resolution set by transponder encoders.

Range Resolution (NM)		Altitude Resolution
2.0 to 5.0	Whole mile increments (i.e. 3.0)	Given in 100-ft. increments, relative to host aircraft
0.4 to 1.9	0.1-mile increments (i.e. 1.3)	altitude (i.e. 600 ft. above is displayed as +06

Table A: Range and Altitude Resolution

Traffic Advisories and Alerts

There is a difference between **traffic detection**, as defined in the previous section, and **traffic alerts** (threats). MRX will not alert you to traffic that does not fall within your specified threat detection envelope, regardless of whether an indication of traffic appears in the display window. The detection, advisory and alert areas are depicted below (not shown to scale).



MRX incorporates a high-volume tone generator to alert you of an impending threat. Two levels of threats are given: traffic **advisories** and traffic **alerts**.

Table B:
Advisory and Alert Messages

Level	Display	Audio
Advisory	ADVISORY	2 Beeps
Alert	ALERT	4 Beeps

The points at which traffic advisories and traffic alerts are given depends on the range setting. The following table defines the various thresholds. Overall, when the detection window is decreased in size by scaling down the range and altitude, the alert thresholds are reduced as well.

Range Setting	If traffic is withing...	Advisory	Alert
5.0 NM (Default)	1.5 NM	+/- 1000 ft.	
	0.9 NM		+/- 700 ft.
3.0 NM	0.8 NM	+/- 800 ft.	+/- 500 ft.
1.5 NM	0.5 NM	+/- 600 ft.	+/- 300 ft.

Table C: Advisory and Alert Thresholds

Regarding altitude settings, the advisories and alerts will be very limited if you have narrowed the altitude window to ±500 feet (as described in "Menus" in the "Buttons and Functions" chapter). For example, if your unit is only looking at traffic at ±500 feet, the unit will only generate an alert if traffic is closer than ±500, and will not generate an advisory, since the lowest altitude threshold is ±600 ft. This is only true for the ±500 foot altitude setting. The other settings (±2000 and ±5000 feet) will allow all of the above thresholds.

Alerts and advisories are determined by the range to the aircraft, are on converging with them, and what range setting you have selected.

How does MRX work?

MRX is a stand-alone, passive system. Passive systems are different from active systems such as TCAS, Skywatch®, etc. Active systems can be found in commercial airliners, corporate jets, and higher-end general aviation aircraft. They actively interrogate aircraft transponders within a specific range. Passive systems like your MRX listen for the replies to these interrogations, as well as ground-based RADAR interrogations.

The Importance of Relative Information

The key to displaying smooth, understandable traffic information is relativity. If the information is always relative to your aircraft, you are your own point of reference. Range is relative to your location, as is the relative altitude (ie +600 above your altitude). For instance, if only the altitude of the other aircraft is known, you would have to find out your own altitude by another glance at your altimeter, then do the math. However, MRX contains these instruments and will do these calculations for you. You will see a live, relative representation that requires no translation, whenever you glance at the MRX display.

Built-in Altimeter for Relative Altitude

One of the features that makes PCAS superior is the built-in altimeter, which establishes an accurate base reference for the relative altitude. Because the altitude information is relative to your altitude, the unit must know your local altitude at all times. Under normal conditions, the following occurs:

1 > Your transponder's encoder broadcasts your local pressure altitude (set at 29.92").

2 > MRX intercepts and decodes your local altitude.

3 > MRX compares this to the altitude from the built-in pressure altimeter to ensure accuracy.

4 > If acceptable, MRX uses the transponder altitude as a base reference.

5 > MRX accurately presents relative altitude information for traffic.

Many times, the local altitude is not available from your transponder, or cannot be accurately relied on. This is normal for all collision avoidance, and MRX will automatically provide a work-around. In these cases, the following occurs:

1 > MRX uses the built-in pressure altimeter as a base reference.

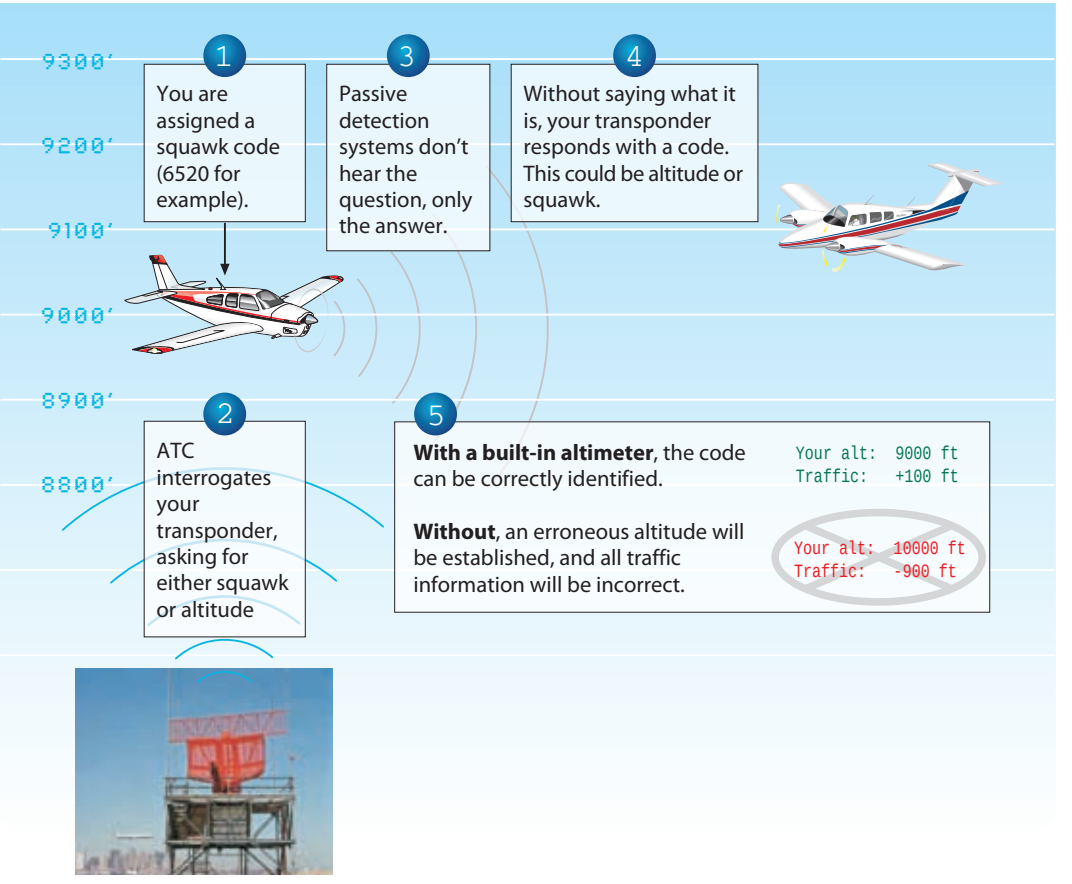
2 > MRX accurately presents relative altitude information for traffic.

As you can see, the most important thing to note is that your MRX will present you with accurate relative altitude information at all times. It is recommended that the altimeter be checked periodically by setting 29.92 in your altimeter and comparing this to the local altitude the MRX displays when no transponder is present. Matching these will ensure overall accuracy.

Portable collision avoidance avionics which display altitude information must rely on a secondary source for altitude rather than the host transponder only. Competitive units which do not incorporate an altimeter will experience the following problems.

Here are the top seven reasons why an internal altimeter must be present:

Scenario 1: "Image Altitude"—Squawk vs. Altitude Code Confusion



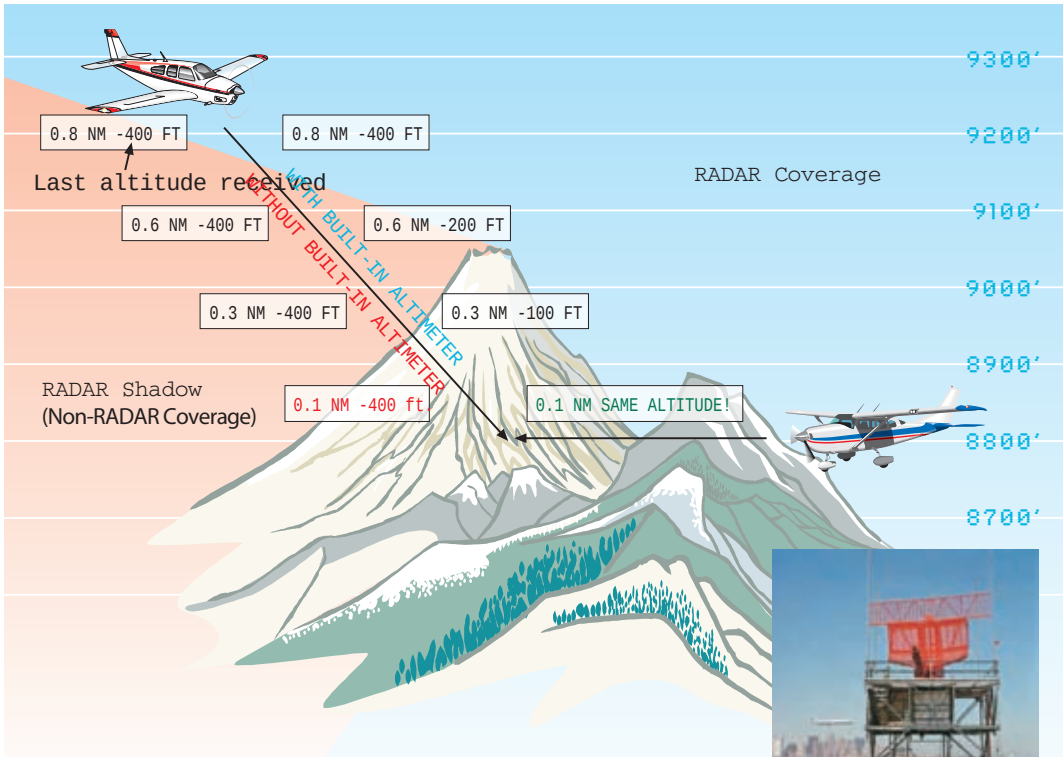
> **Problem:** Both altitude and squawk code are encoded in the same fashion. Without an internal altimeter, errors will result if squawking one of the hundreds of possible IFR or ATC codes because the transponder is sending "image altitude", a squawk code that happens to match up with an altitude code.

> **Solution:** PCAS recognizes the hundreds of possible squawk codes possible which can be confused as an altitude code. The internal altimeter allows PCAS to select the correct altitude in this situation.

> How can ATC tell the difference? On a different frequency, ATC is interrogating and asking for either squawk or altitude. If a Mode A (squawk) interrogation is issued, a Mode A reply is expected, and the pulses will be decoded that way. Likewise, if a Mode C (altitude) request is made, the data received from the aircraft will be calculated as

altitude.

Scenario 2: Temporary RADAR Shadows

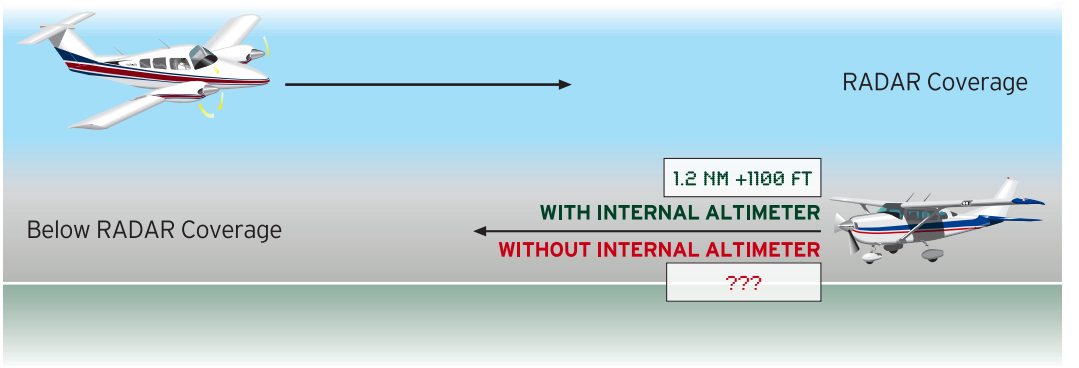


> **Problem:** When entering a temporary RADAR shadow, without an internal altimeter, the last received altitude would be carried into the shadow area, resulting in erroneous traffic information and potentially dangerous results.

> **Solution:** PCAS recognizes when the transponder stops sending altitude information and uses the internal altimeter. In this example, the unit will display converging altitudes.

> RADAR shadows exist in many areas. The above example is only one possibility of RADAR shadowing. Less dramatic shadowing can occur in other situations. When turning final to land, if the antenna on the bottom of the fuselage is turned away from the ground RADAR station, momentary shadowing may occur. In this critical moment, the internal altimeter will take over and allow for precise traffic information. Without this, the same dramatic results above may occur.

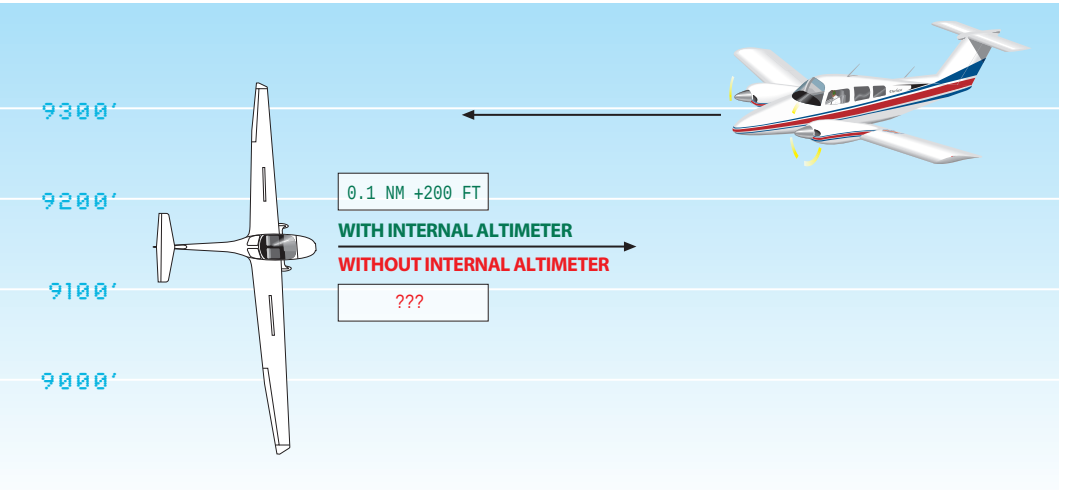
Scenario 3: Aircraft Below RADAR Coverage



> **Problem:** When flying below RADAR coverage, no local altitude information can be gathered.

> **Solution:** Again, the internal altimeter allows PCAS to function normally, establishing a base reference for your altitude and displaying relative altitude for traffic.

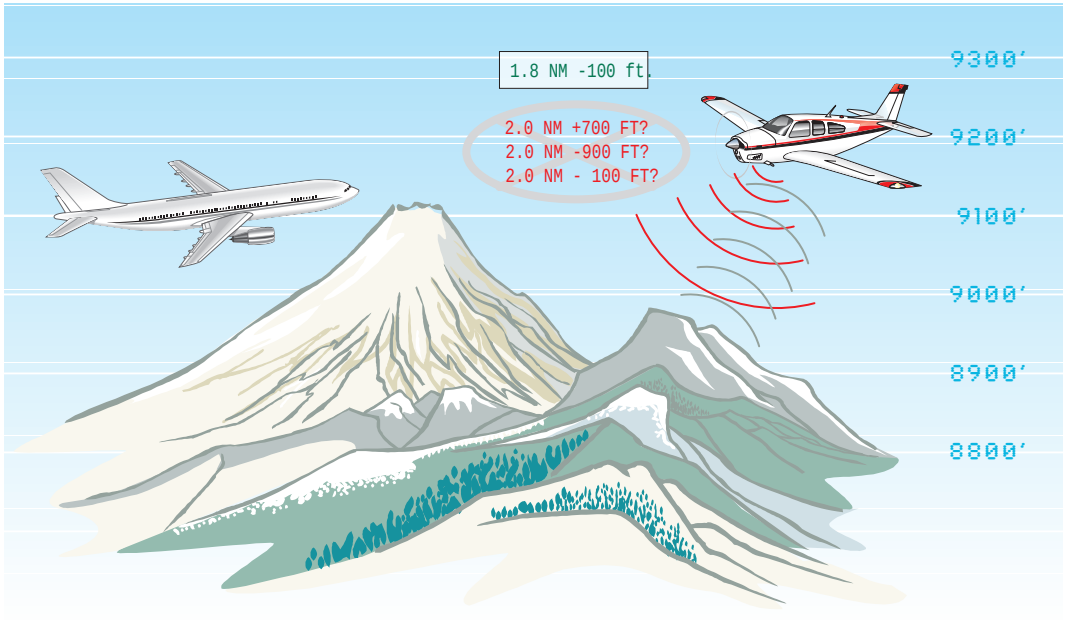
Scenario 4: No Transponder (ie Glider) or Transponder Not In ALT Mode



> **Problem:** Another problem with relying only on your transponder for altitude information exists if you don't have a transponder or you forget to turn your transponder to the "ALT" mode.

> **Solution:** PCAS functions normally when depending on only the internal altimeter, making it the only collision avoidance system available for gliders. PCAS will also alert you if you forgot to turn your transponder on.

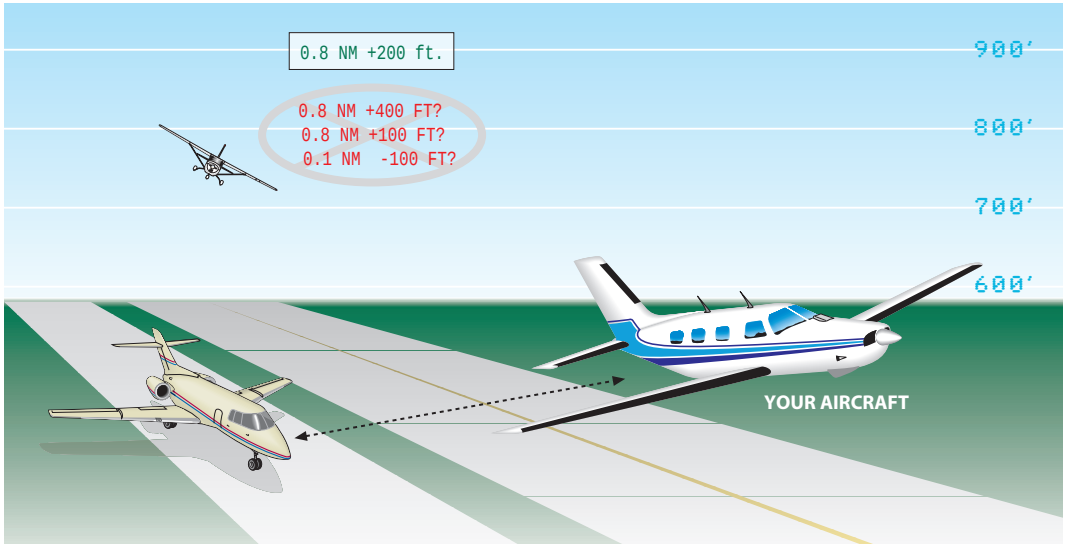
Scenario 5: Multipath Anomaly



> **Problem:** Relying only on the transponder for altitude can result in situations where the transponder's own signal is reflected, and delayed overlaps distort the overall signal, leaving no clear altitude code.

> **Solution:** PCAS recognizes the distorted echo of the transponder signal, and the internal altimeter error correction logic determines the correct altitude.

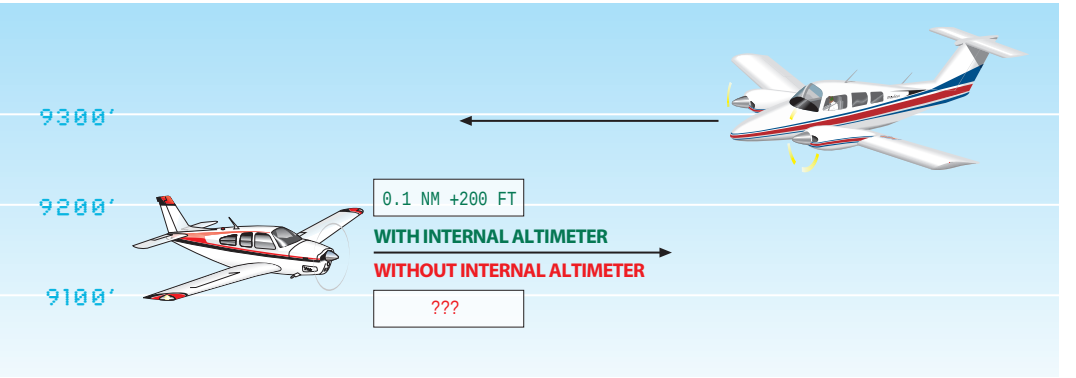
Scenario 6: Nearby Transponder Confusion



> **Problem:** In a crowded airport environment, especially on final or takeoff, confusion over which aircraft's transponder altitude to use would be an obvious problem without an internal altimeter.

> **Solution:** PCAS recognizes other transponders as "Not Mine" with altimeter logic algorithms.

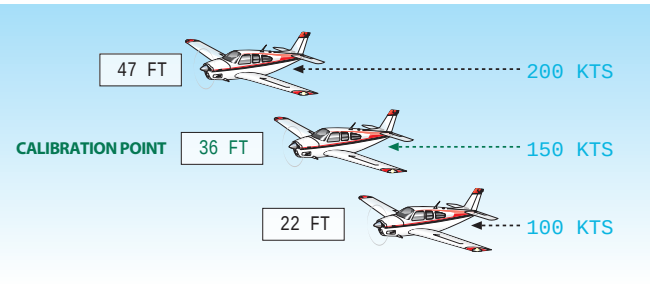
Scenario 7: Mode A Transponders



> **Problem:** Similar to scenario four above, aircraft that do not have a Mode C transponder cannot use a device without an internal altimeter.

> **Solution:** Again, the internal altimeter sets a reference for proper traffic detection.

How altitude is accurately determined inside a cockpit



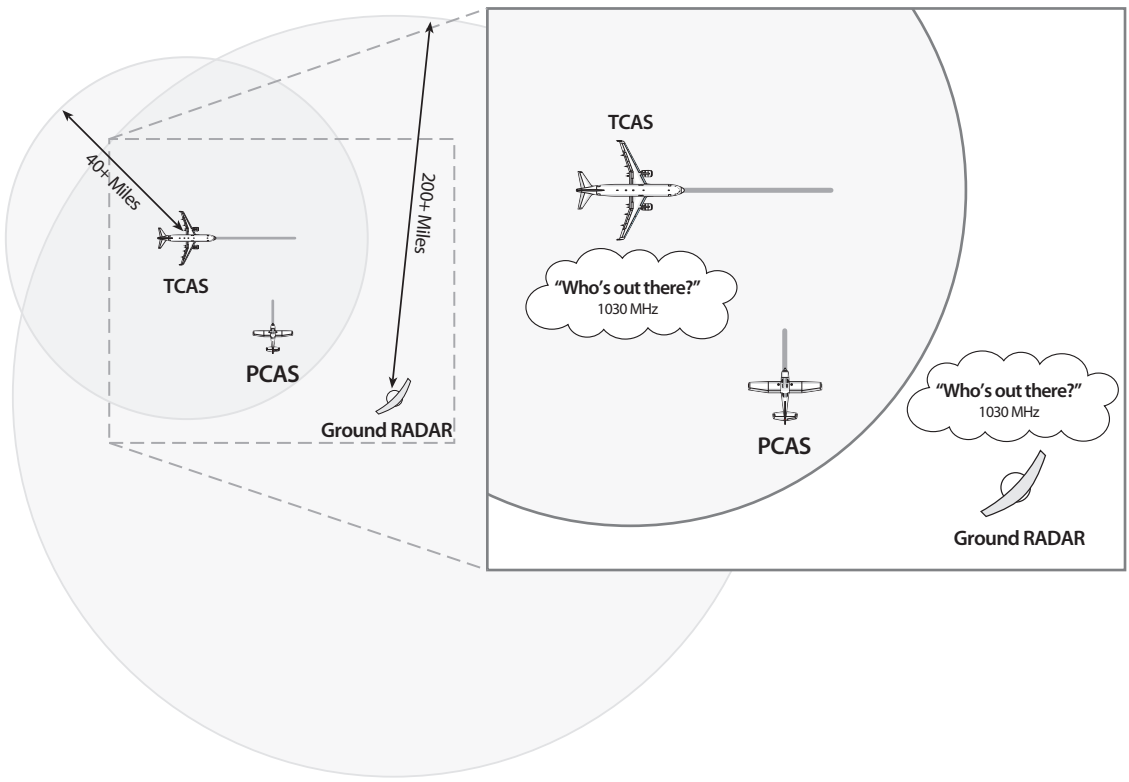
Once airborne, PCAS uses corrective altitude algorithms to adjust for the minor Bernoulli effects encountered. While this difference in altitude is minute, it is still accounted for. The result is an internal altimeter as accurate as altitude encoders.

To test this, turn on the alternate static source to pull static pressure from inside the cabin. Watch your altimeter. The difference should be around +36 ft.

What does MRX detect exactly?

To explain how the system works, consider the following illustrations:

1 > To start the cycle, an interrogation is sent out from ground-based RADAR stations and/or TCAS or other actively interrogating systems in your area. This signal is sent on 1030 MHz. For TCAS, this interrogation range can have a radius of 40 miles or more from the interrogation source. The Ground RADAR range can be 200 miles or more.

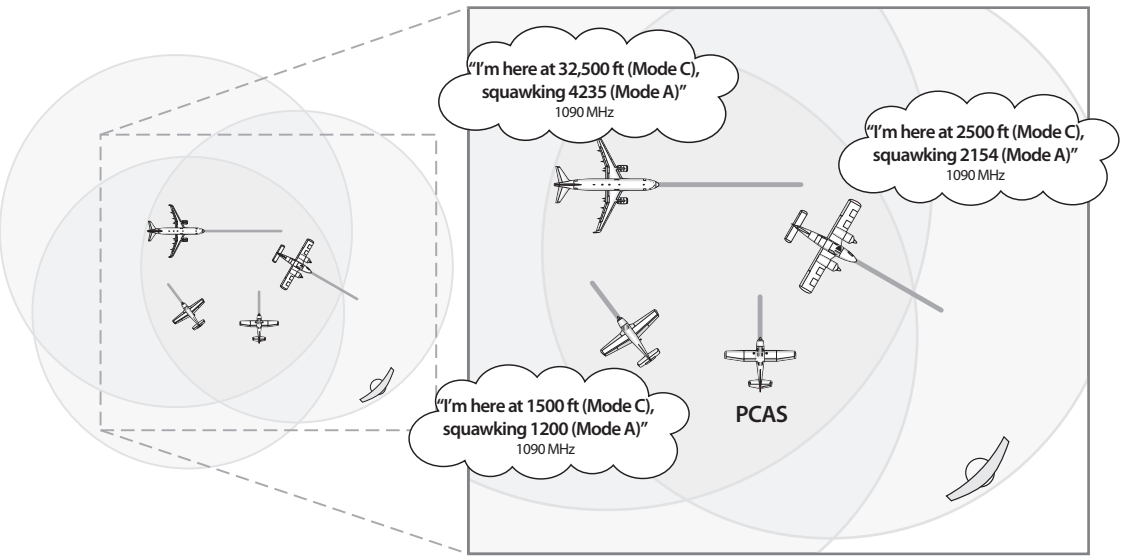


2 > The transponder on any aircraft within range of the interrogation replies on 1090 MHz with their squawk code (known as Mode A) and altitude code (or Mode C). The altitude information is sent in an encoded format.

Mode S transponders also reply on this frequency, and encoded within the Mode S transmission is the Mode A (squawk) and Mode C (altitude) information.

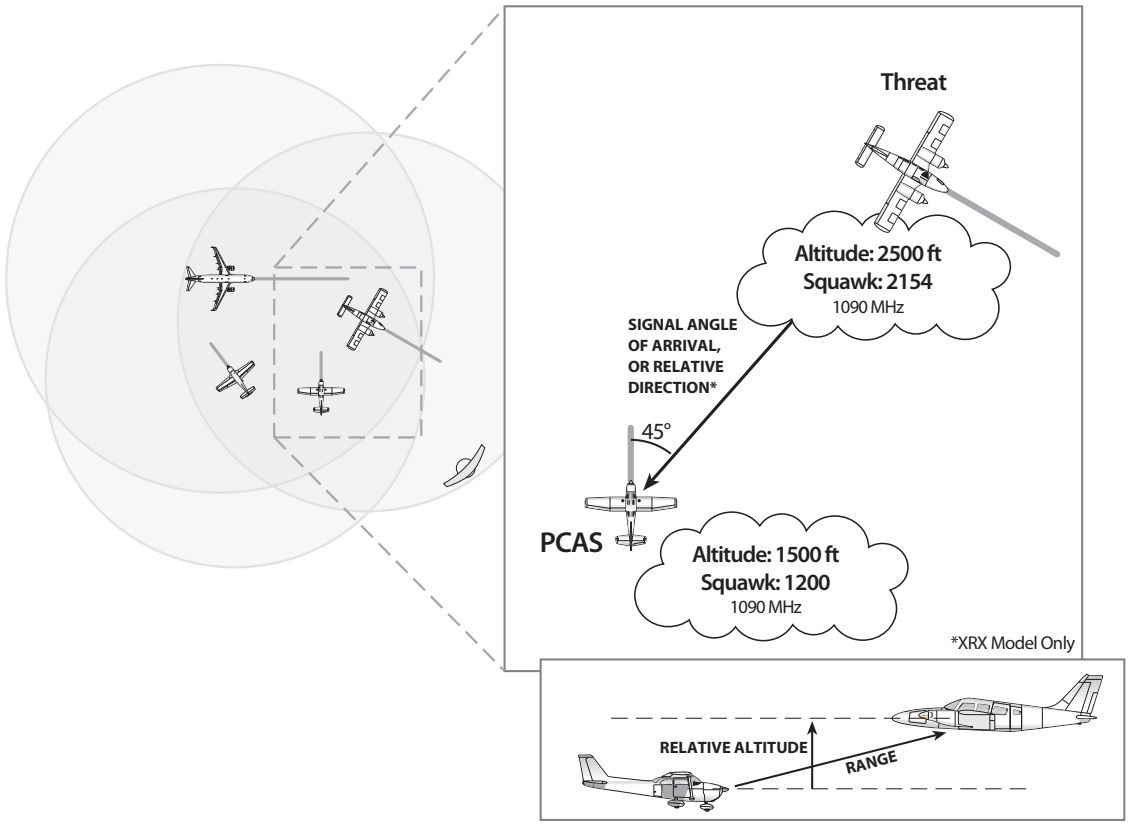
Military aircraft also respond on this frequency but use a different transmission protocol (see Step 3).

Your aircraft's transponder should also reply. However, PCAS watches for this signal and will not report it as a threat aircraft. The unit may use this information to establish base altitude for use in step 4.



3 > Any aircraft reply within the MRX detection window (maximum 5 miles) will be received. The range is computed, the altitude code is decoded, and the signal angle-of-arrival is determined. PCAS will recognize interrogations from TCAS, Skywatch, and any other "active" system, military protocols, and Mode S transmissions.

4 > The altitude of the aircraft (in the example, 2500 ft.) is compared to your local altitude (i.e , 1500 ft.) and the relative altitude is calculated (i.e., 1000 ft. above you). With altitude and range determined, PCAS displays this information and stores it in memory.



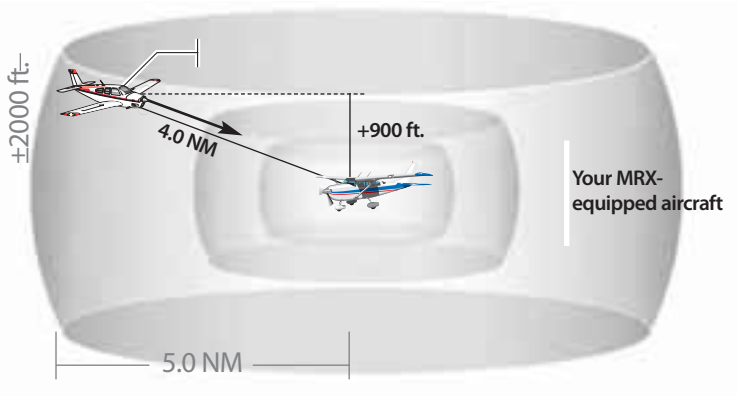
5 > If additional aircraft are within detection range, the above process is repeated for each aircraft. The top threat is displayed.

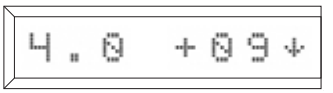
The greatest threat is determined by looking at aircraft within the detection window you set up and comparing primarily the vertical separation (± relative altitude), and secondarily the range to the aircraft currently being displayed. PCAS uses proprietary algorithms to determine which of two or more aircraft is a greater threat. See flight scenarios later in this chapter for more information.

Example Flight Scenarios

Many different flight scenarios exist, of course, but you will find common situations that prevail in everyday flight. The examples on the following pages illustrate what to expect in these common situations and how to visualize the aircraft around you.

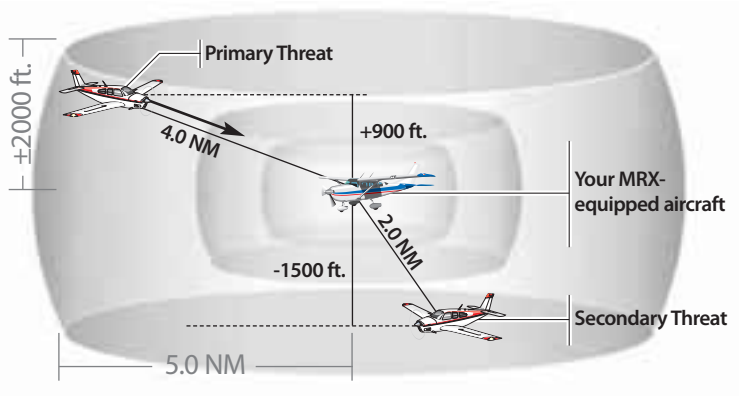
Example One: A Single Aircraft

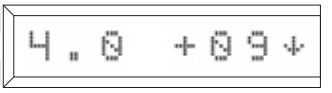




In this example, there is only one aircraft in the detection window you have set (in this case, the default range and altitude). If the aircraft is 4.0 NM away and 900 feet above and descending, this is what the MRX will display. This is NOT an alert situation. However, an attempt should be made to identify this aircraft if the range gets below two miles. At four miles, it is unlikely you would be able to see the aircraft; however, if the range and altitude continue to count down, this could become a threat.

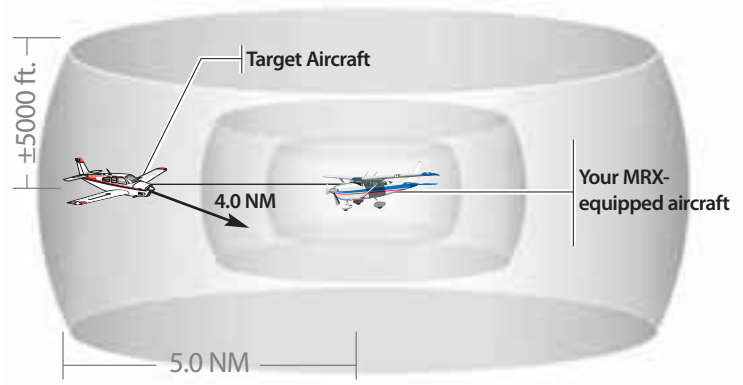
Example Two: Multiple Aircraft

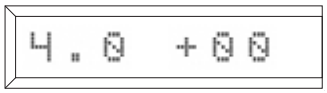




MRX prioritizes aircraft based on relative altitude. The aircraft at the closest relative altitude becomes the priority. In this example, the aircraft at +900 feet is a greater threat than the aircraft at -1500 ft, even though the aircraft below is closer in range (2.0 NM vs. 4.0 NM).

Example Three: Aircraft at Same Altitude





Aircraft at the same altitude as your aircraft will be represented by "00". If the aircraft was descending to your altitude, the unit will display "+00", as in this example. If the aircraft was climbing to your altitude, "-00" is displayed. This is connected with the vertical trend arrow, which represents the target aircraft's ascent or descent over time.

Strengths and Limitations

Strengths

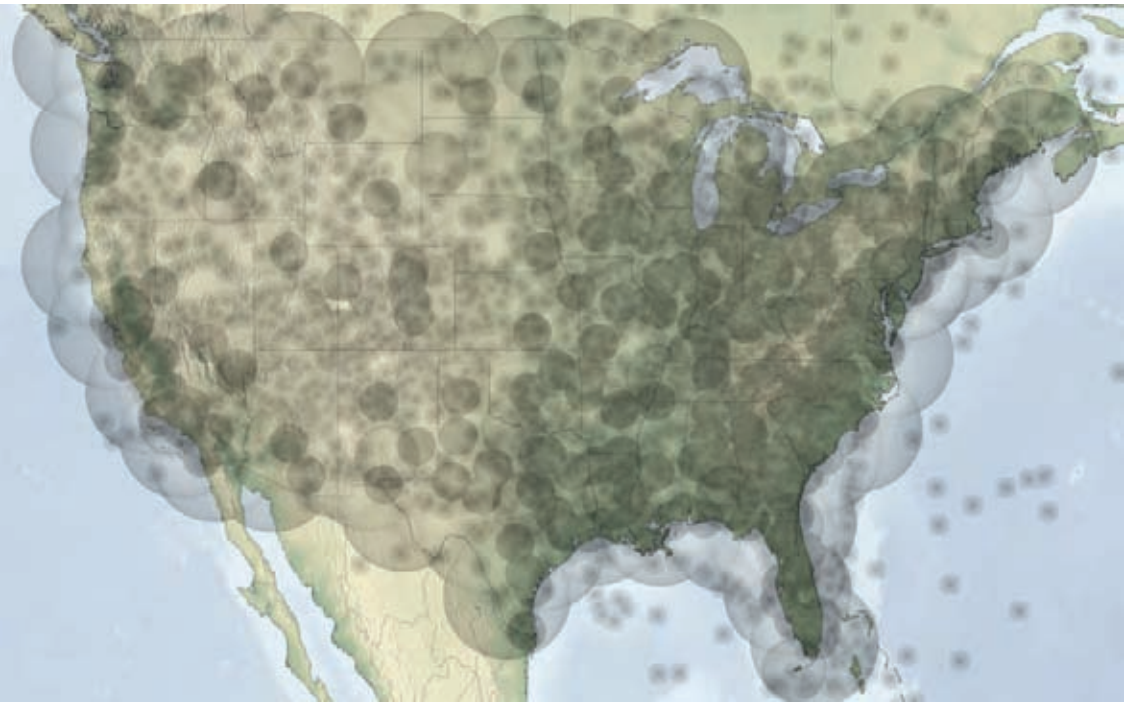
Ground RADAR and TCAS Network Coverage

MRX is a passive system, meaning it listens to replies from other aircraft. Other aircraft are responding to interrogations. There are two types of interrogation networks: Ground RADAR installations and TCAS- or other active system-equipped aircraft.

Ground RADAR installations provide ATC with aircraft data by interrogating outward from the sweeping antenna, pictured here. The range of each installation depends on the type of surrounding terrain and geography, but is usually 100-200 miles in diameter.

Overhead, systems that interrogate, or active systems, exist which make up an even better network of interrogation. Examples of active systems are TCAS, Skywatch, and Ryan/Avidyne active systems. Because these systems are airborne, they are not limited by geographical features and provide an excellent platform for interrogation.

A passive system which does not interrogate, such as MRX, only works if the interrogations are present. However, it is important to note that the combined effect of both overlapping networks provides for a nearly 100% coverage in the United States. The illustration below demonostrates this when the coverage of terminal, enroute and military RADAR is combined with TCAS interrogations from aircraft at any given moment.The same type of systems exist in countries abroad, especially the same airborne TCAS-based systems. The most important thing to remember is that interrogations happen virtually everywhere you may fly.



Zero False Alerts

MRX boasts the unique ability to filter out any erroneous signals and only display verified transponder-equipped aircraft. Incoming signals must be completely decoded, the Mode A/C must correctly correspond to a valid altitude code, and MRX must be able to do this twice with the same aircraft. This process, among others, virtually guarantees that, if an aircraft information is being displayed, it can only be from a valid transponder-equipped aircraft.

Limitations

MRX is not compatible for use in pressurized aircraft. MRX incorporates a built-in altimeter to help determine local altitude and will not function properly in a pressurized cabin.

Visually Identifying Aircraft

Please be aware of what you can and can't visually identify. Many pilots will experience a situation where the unit will display an aircraft and attempts to visually identify it are unsuccessful. The following is a short list of visual impairments to consider:

- Even to a well-trained eye, general aircraft beyond 1.5 to 2 miles away are too small to see
- Visual effects, such as ground clutter, optical myopia, and haze can obscure aircraft
- Only a relatively small "slice" of the 360° area around the cockpit is within the pilot's scan. Aircraft above, below, and behind may be blocked by your aircraft and much more difficult to see.
- Aircraft at or about your same altitude tend to appear 200 feet lower for every half mile of distance between you and the aircraft. This is an optical illusion which is caused by the curvature of the earth (the horizon) combined with your aircraft angle of attack.

MRX Cannot Detect All Traffic

MRX, along with all other collision avoidance technologies, cannot detect all aircraft. If another aircraft does not have a transponder, if the transponder is not turned on or to ALT, or in the rare case that no interrogation signal is present, there will be no reply for MRX to detect. While shadowing of signals can occur, MRX is programmed to correct for many instances. However some scenarios which can cause signal loss, or degradation, are:

- **Target aircraft banking > 30° (top of aircraft visible, bottom turned away):** This can happen because the other aircraft's transponder antenna is on the bottom of the aircraft, however when the target aircraft is < 1.0 NM this is usually not a factor.
- **On the ground, such as the run-up area Target aircraft approaching to land:** The range would be significantly further than actual. The reason is because as the other aircraft approaches, their transponder signal reflects off of the ground and phase cancellation becomes very prominent when they are < 500 feet above ground and coming towards you. When in the run-up, keep this in mind and consider the range to be 50% closer than what is displayed. This is not a problem in the air, since MRX antenna reception is not competing with the ground and forward lobes of the target aircraft for signal reception.

Recognition & Reaction Time

Running time	Action	Seconds
00:00	See object	0.1
00:00	Recognize aircraft	1.0
00:01	Become aware of collision course	5.0
00:06	Decision to turn left or right	4.0
00:10	Muscular reaction	0.4
00:10	Aircraft lag time	2.0
00:12	**TOTAL TIME**	**12.5**

Table D: Recognition & Reaction Time

	Seconds to Impact	
Range	**600 MPH***	**360 MPH***
10 miles	60 secs.	100 secs.
6 miles	36 secs.	60 secs.
5 miles	30 secs.	50 secs.
4 miles	24 secs.	40 secs.
3 miles	18 secs.	30 secs.
2 miles	**12 secs.**	20 secs.
1 mile	**6 secs.**	**10 secs.**
0 5 mile	**3 secs.**	**5 secs.**

Table E: Time to Closest Approach Point (CAP)

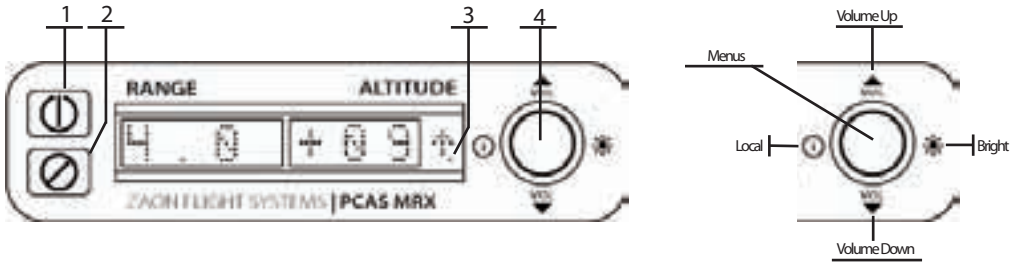
The importance of early warning cannot be stressed enough when it comes to detecting a potential threatening aircraft. These charts indicate how combined aircraft speed and distance play a role in determining your reaction time.

According to the FAA, a typical response time is 12 5 seconds. This translates to a one- to three-mile minimum response distance from an incoming aircraft. PCAS will help you increase awareness and response time.

The data presented is from FAA AC 90-48C.

*Combined A/C speeds. BOLD times mark when insufficient time remains to alter course.

Buttons and Functions



1 > **Power**

Press once to turn unit on. Press again to turn unit off.

2 > **Mute**

Press to mute any audio output; press again to turn mute off and hear audio alerts. Once pressed, the unit will remain in mute until the button is pressed again.

3 > Mute will be indicated by a flashing dot in the right corner of the display.

4 > **Multi-function Switch**

5-way rocker switch

5 > **Volume Up**

Also functions as Menu Selector Up (in menu mode)

6 > **Volume Down**

Also functions as Menu Selector Down (in menu mode)

7 > **Menu Mode**

Enters menu mode, then advances through menus and back to traffic screen

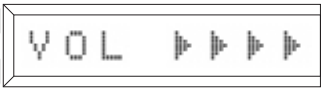
8 > **Local**

Displays local squawk code and altitude information

9 > **Brightness**

Changes the brightness level of the display

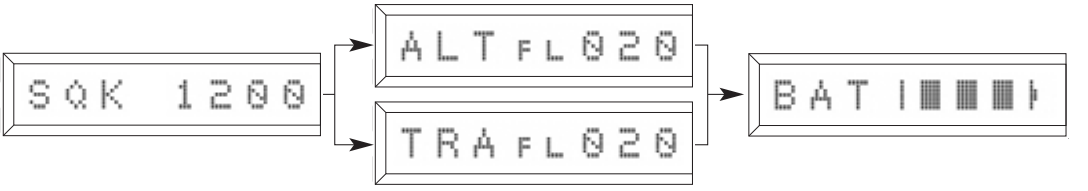
Volume Up/Down



Pressing the multi-function button **up** or **down** while in the traffic screen will change the volume level of the audio alerts. The current volume level will be displayed for 2 seconds after pressing the button up or down.

The volume level is represented by a number of arrows, as indicated here.

Local (LOC) Button



To view local squawk code and altitude, briefly press the multi-function button to the **left** (LOC) while in the traffic screen. Information in the following sequence will be displayed:

1 > **Mode A (Squawk)**

SQK (Squawk 4-digit code) will be displayed for 2 seconds. If no local transponder is present or detectable, SQK 0000 will be displayed.

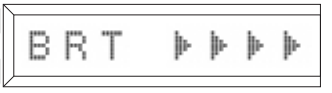
2 > **Mode C (Altitude)**

ALT or TRA FL[3-digit flight-level altitude] will be displayed for 2 seconds. ALT will be displayed if the altitude is taken from the internal altimeter. TRA will be displayed if the altitude is taken from the transponder's encoder output. See "Built-in Altimeter for Relative Altitude" in the "Understanding PCAS" chapter for more information.

3 > **Battery Life**

The remaining battery life will be displayed for 2 seconds. Three blocks indicate full charge, one block indicates batteries should be replaced as soon as possible. If MRX is plugged into aircraft power, three blockes should be indicated. Battery life is also displayed in the startup sequence, immediately after the Firmware version number is displayed.

Brightness (BRT) Button



Pressing the multi-function button to the right (BRT) while in the traffic screen will allow you to change the brightness of the display. The current brightness level will be displayed for 2 seconds after pressing the button right. For night viewing, reduce the brightness to avoid eye strain.

To change the brightness:

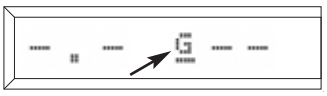
1 > Press **BRT** to display the current brightness level

2 > Press the multi-function button **up** or **down** to change the brightness

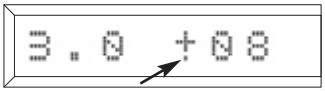
3 > After you have selected the desired brightness, wait 2 seconds and the screen will revert back to the traffic screen.

Ground Mode vs. Flight Mode

Like some TCAS systems, MRX gives you the option upon startup of operating in ground mode or flight mode. If the unit is in **Ground Mode**, aircraft below you and up to 200 feet above you are ignored. This is useful when on the ground and you wish to ignore the aircraft taxiing around you in favor of detecting aircraft in the pattern or on final approach. As soon as you climb (or descend) 200 feet, it will automatically switch to Flight Mode once 200 feet of climb is detected from the time you turned the unit on. Ground Mode reduces ground clutter, or the detection of aircraft at the airport with their transponders turned on. In **Flight Mode**, the unit will detect aircraft both above and below you.



Ground Mode Indicator (No Traffic)



Ground Mode Indicator (With Traffic)

To set the unit in Ground Mode, turn the unit on and press the **menu** button during the startup sequence. Ground Mode will be indicated by a G next to the altitude if there is no traffic, or a + next to the altitude if there is traffic. No alerts will be given when the unit is in Ground Mode.

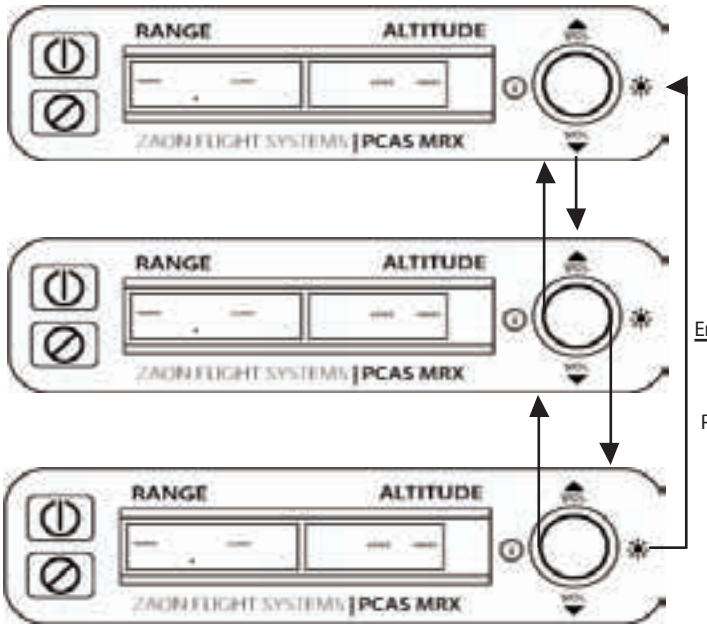
If MRX is in Ground Mode, aircraft below and up to 200 feet above you will be ignored in order to eliminate the detection of aircraft on the ground.

To set the unit to Flight Mode, press the **up arrow** during this sequence. If no button is pressed during the startup sequence, the unit will automatically default to Ground Mode after 35 seconds.

Restarting the Unit in Flight

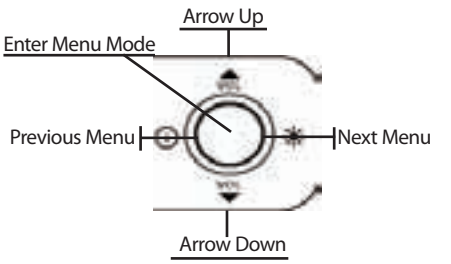
If you turn on or restart the unit in Ground Mode while in flight, the unit will not detect aircraft below you and up to 200 feet above you until you climb 200 feet. If this happens, restart the unit in Flight Mode by turning the unit off, then on, then pressing the **up arrow** instead of the menu button at the warning screen.

Menus



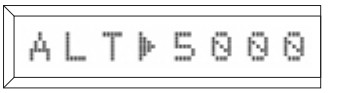
MRX uses two simple menus to define the parameters for your flight, altitude selection and range selection. Any changes you make to these settings will be saved.

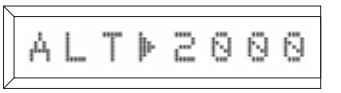
Use the multi-function switch to navigate through the menus as follows:

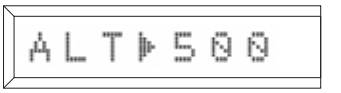


Menu 1: Altitude

The purpose of the ALT menu is to limit threat indications based on altitude separation from your aircraft, especially when operating in dense traffic environments. The available selections are ±5000 feet, ±2000 feet, and ±500 feet, relative to your altitude. The default selection is ±2000 feet.







To select an Altitude Limitation:

1 > From the Traffic Display Screen, press the multi-function button once to view the ALT menu.

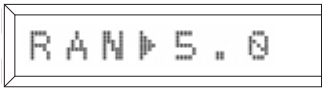
2 > Press the multi-function button **up** and/or **down** until the index pointer designates the altitude you desire.

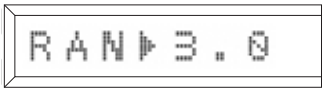
3 > To advance to the range screen, press the multi-function button **right** (see next section, step 2).

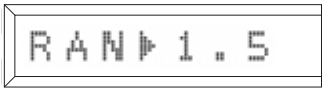
When traffic is higher or lower than the altitude sleected in themenu options, no traffic information will be displayed.

Menu 2: Range

The RAN menu allows you to select the horizontal detection window, or range. The available selections are 5.0 NM, 3.0 NM and 1.5 NM radius, relative to your aircraft. 5.0 NM is the default selection.







To select a Range Limitation:

1 > From the Traffic Display Screen, press the multi-function button once to view the ALT menu.

2 > Press the multi-function button **right** to view the RAN menu.

3 > Press the multi-function button **up** and/or **down** until the index pointer designates the altitude you desire.

4 > To return to the traffic screen, press the multi-function button **right**.

Administrative Menu

Your MRX unit comes fully calibrated and ready to use. However, if the altimeter starts to drift, adjustments can be made using the admin menu. This menu provides access to altimeter and suppression calibration screens.

To enter Admin mode:

1 > Press and hold the **mute** button

2 > Press the multi-function button **down** within 3 seconds

Page 1: Altimeter Calibration

It is recommended that you check your altimeter every 6 months by comparing your aircraft altimeter's pressure altitude (tuned to 29.92) to the MRX pressure altitude displayed in the local sequence. If the altitude is off by 200 feet or more, recalibrate your MRX using this procedure.

If the MRX internal altimeter is not correct, traffic information may be displayed incorrectly or not at all.

The following actions can be performed on this page:

A > Press the multi-function button to continue to the next page

B > Adjust the internal altimeter using the procedure below.

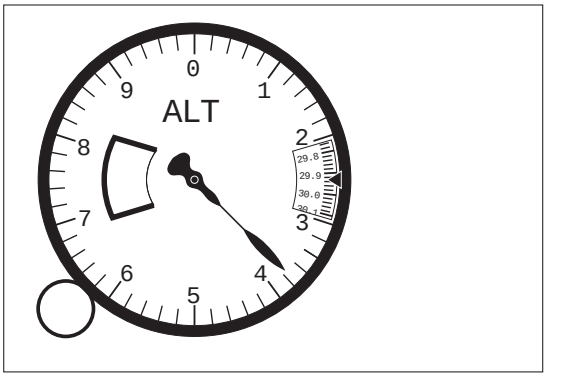
C > Press the multi-function button **right** for an audio test beep

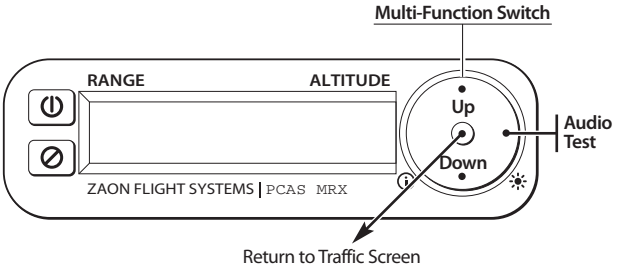
To adjust your altimeter:

1 > In your aircraft, enter 29.92 into the Kollsman window of your altimeter

2 > Press the multi-function **up** and **down** buttons to match your aircraft's altimeter pressure altitude of 29.92. The MRX displays altitude in 100 ft. increments, or flight levels. For example, 003 equals 300 feet.

Pressing up or down will change the altitude setting. However, when you switch from changing altitude down or up, the altitude will reset to the factory default setting. Simply continue from this point to press the multi-function **down** or **up** buttons until you achieve the desired altitude. To continue to the next screen, press the multi-function button [A].





Page 2: Internal Adjustment

This page is for internal adjustments only. **Do not make any changes on this page.** Press the multi-function button to save the altimeter settings from the previous page and return to the traffic display.

Frequently Asked Questions

How does PCAS detect traffic?

PCAS is a passive, transponder-based detection system. Passive refers to the sensing method. Passive systems listen for replies from transponders to interrogations. In comparison, active systems send the interrogation to "spark" the replies from aircraft within the detection area. Passive systems are extremely effective in most areas because of the abundance of interrogations from other active systems. Ground-based RADAR and airborne TCAS systems are examples of active systems. PCAS is able to receive interrogation responses sparked by both of these methods. In fact, in an area of average coverage, PCAS rejects 50% or more of the incoming signals because of redundancy. Refer to the "Understanding PCAS" chapter for more on this.

Are there any areas in which MRX will not detect traffic?

Possibly. However, coverage should be greater than 90% in the US. Because PCAS is a dual-environment system, it can detect replies to both ground RADAR and TCAS interrogations. Refer to the illustration in "Ground RADAR and TCAS Network Coverage" in the "Understanding PCAS" chapter for approximate coverage areas. Ground RADAR sites cover the majority of the US, but because of the altitude sensitivity of the RADAR interrogation, pockets do exist when a primary RADAR site is not close-by or is obstructed by hills or mountains. However, TCAS systems in aircraft (usually airliners flying at 30,000+ ft overhead) broadcast to 100 miles and are not limited by ground clutter obstructions. It is very common to be at an airport in which you must climb to 1000+ feet before ATC can detect you (through ground RADAR) but MRX will detect other aircraft around you because of an airliner flying overhead with TCAS.

Will MRX work if I don't have a transponder?

Yes. A local transponder is usually used to determine the local altitude, since information given is relative to your altitude. However, because MRX incorporates a built-in altimeter as a backup source for local altitude, a local transponder is not required. This is useful for use in gliders, hot air balloons, or ultralights that are usually not transponder equipped. Regardless of a local transponder, MRX will always be able to determine the local altitude, ensuring accurate traffic information.

Will MRX detect another aircraft that does not have a transponder?

No. As with all collision avoidance systems, the target aircraft must have a functioning transponder. Without a transponder, there is no signal to detect.

Why does MRX need an internal altimeter?

Because the altitude information is relative to your altitude, the unit must know your local altitude at all times. One of the features that makes PCAS superior is the patent-pending built-in altimeter, which establishes an accurate base reference for the relative altitude. Portable collision avoidance avionics which display altitude information must rely on a secondary source for altitude rather than the host transponder only. Competitive units which do not incorporate an altimeter will experience the following problems. For an in-depth explanation of this, see "Built-in Altimeter for Relative Altitude" in the "Understanding PCAS" chapter.

How does PCAS compare to TIS?

TIS, or Traffic Information Service, refers to the broadcast and receiving of traffic information from Ground-Based Transmitters (GBTs) via a transmitted RF signal. Contained in this signal is the information ATC uses to display traffic within the service area. TIS offers some advantages, but a few disadvantages when comparing to the way PCAS delivers traffic information.

It is important to note that MRX gives two of the three "dimensions" of traffic information (range and relative altitude), while both PCAS XRX and TIS also give direction.

> TIS offers a fairly comprehensive view of traffic, usually displayed onto a moving map. However, TIS information is limited to the service area, or area in which GBTs are equipped to send a TIS signal. As of this printing, less than 50 TIS stations exist in the US. In addition, the Mode S TIS broadcast is being scaled down in preparation for a new datalink, ADS-B. Once outside the service area, traffic is unavailable. PCAS, on the other hand, is not tied to a ground-based service. Traffic displayed on the PCAS screen is detected and computed independently of a ground-based service. In fact, the only thing PCAS needs to function is a Mode C transponder in the other aircraft (which all other collision avoidance systems need as well), which makes PCAS truly a peer-to-peer system.

> TIS requires a Mode S transponder and a way to visually display the traffic information, usually on an MFD. While the end result is clear and concise, the cost of such systems and installation can be expensive for general aviation. PCAS is completely self-contained and does not require any additional hardware to function. It's portable as well, meaning that it can be taken from aircraft to aircraft, or removed for security.

> PCAS can derive its information from both ground-based interrogations as well as TCAS-equipped aircraft flying overhead. Considering the ground clutter limitations of RADAR, PCAS often gets more information from TCAS interrogations than ground RADAR, especially when flying low to the ground. TIS is ground-RADAR-based only, and aircraft flying below the RADAR horizon will not be detected.

> PCAS information is updated as soon as the target transponder sends information, which is usually several times per RADAR sweep or TCAS interrogation. TIS information must be processed through several ground systems, rebroadcast, received and displayed. Traffic information, particularly altitude information, can have considerable delays.

> One other consideration is range calculation. PCAS displays slant range, or true distance, in estimated miles. TIS displays range from an overhead-view perspective. For example, if the target aircraft is 2500 feet directly above you, the closest PCAS will indicate the traffic is 0.5 NM. TIS may display the traffic on top of your position in a 2-D fashion. However, TIS range calculations are time-based, which can be more accurate at distance. The relative altitude would be indicated the same on TIS as with PCAS.

Is the audio beeping loud enough to be heard over a headset in the cockpit?

MRX incorporates an internal audible tone generator (3.2 KHz) which beeps to advise the pilot and passengers of a traffic alert or advisory. This tone is high-pitched and at a volume that can be heard over the noise level in a standard cockpit, similar to the stall warning horn or the outer marker tone. Because noise-cancelling headsets generally reduce noise at a much lower frequency (approximately 400 Hz and below), they have little effect on restricting the volume of the tone generator, which can be heard clearly through ANR headsets. The tone is a short double beat for advisories, or a triple-beat for alerts. The tone is only heard once when the advisory or alert is first announced.

Does PCAS interface with other systems (such as moving maps or MFDs)?

No. Due to size and cost constraints, MRX is a stand-alone system. Other PCAS systems can interface with third-

party devices. Please refer to our website for more information.

How well does the unit perform in a high-temperature environment?

Even though PCAS was designed to sit atop the glareshield, it should function normally in high-temperature environments, such as summer conditions. Several design elements assist with keeping PCAS within its operating temperature range. The housing has been specially designed to deflect much of the heat from direct sunlight. Electronic components were selected specifically for high heat tolerances. As with any electronics, heat can adversely affect performance. However, PCAS has been successfully tested to function normally at the top end of the 150°F (65°C) temperature range.

How does MRX know my altitude and squawk?

The local altitude comes from either the built-in altimeter or from your transponder encoder, if one is present, broadcasting, and within tolerance. The altitude from your transponder is always double-checked against the built-in pressure altimeter to ensure accuracy. If any discrepancies occur, the unit defaults to using the built-in altimeter. The local squawk code comes from your transponder's encoder output, if MRX has successfully linked to your transponder. Otherwise, a code of "0000" is displayed. The squawk code can be found by pressing the "LOC" button.

Is there any other place to position MRX than on the glareshield?

The MRX antenna must be in plain sight of other aircraft. For most aircraft, the glareshield offers the best mounting position. However, the MRX unit may be used in any location, including mounted in the dash, as long as the antenna has a clear, unobstructed view. You may alternately remotely mount the antenna using an optional antenna extender, which allows the antenna to be mounted on a side or rear window, and allows the unit to be placed anywhere in the cockpit, such as under the dash. Installation kits may be available as well. Visit our website for more info.

Why can't I view more than one aircraft at a time?

MRX was designed to indicate the top priority, or primary aircraft. Additional aircraft are tracked, but are not as much of a potential threat than the aircraft displayed. This aircraft represents the greatest threat to you. If this information was replaced, even temporarily, by a lesser threat, the greater threat may be overlooked. This would put the pilot at risk. MRX smartly manages traffic prioritizing so that the pilot doesn't have to.

Will MRX work in a pressurized aircraft?

MRX is not compatible for use in pressurized aircraft. MRX incorporates a built-in altimeter to help determine local altitude and will not function properly in a pressurized cabin.

Do the batteries need to be removed when powering the unit from aircraft power?

No. Plugging in the unit to aircraft power disconnects the battery power automatically. However, if you are going to operate the unit for a prolonged period of time from aircraft power, remove the batteries, especially if you are installing the unit in the instrument panel. Unused batteries may leak and cause damage to the unit.

Troubleshooting

Power

Should the MRX unit be turned off when starting up the aircraft?

When using aircraft power it is always a good idea to keep any avionics off during startup. Since the aircraft has only two sources of power, the battery and the alternator, engine starting causes the battery to contribute considerable amperage to the starter which reduces it's output voltage below that of acceptable levels for most avionics. While older, tube-style avionics are not as affected, newer processor-based avionics, such as MRX, may not deal well with this situation, even though most avionics devices turned on during this time period should simply reset itself. A potential power surge does pose some risk, however this is not very likely since the output voltage on most alternators are protected from such.

Occasionally, when the power button is pushed, the unit turns off as soon as the button is released.

This system is turned on through a momentary press of the power button for less than one second. If the power button is held down for too long, the system will shut off when pressure is released. Press the power button for no more than one second, then release.

Unit powers on, the display briefly illuminates, then unit immediately shuts off.

If using **battery power**: Once batteries are drained below a level which can sustain proper functioning, the unit will shut itself off upon startup to prevent erroneous operation. Change batteries.

If using **aircraft power**: Check all connections for proper installation. Unit will shut off automatically if a short in the system is detected. Turn on unit. Check to make sure the minimum voltage and current are available through your power connector, both at the aircraft and at the tip of the power adapter (see Appendices: Specifications). If problem persists, try using batteries to determine if the problem lies with the unit or the power source. If unit never starts up, unit needs to be repaired.

Upon powering up, unit displays a garbled or semi-garbled screen, resets, then operates normally.

This is normal and simply means unit was reset (powered off then back on) too quickly. The unit will sense the improper startup and reset itself.

Unit displays "Low Battery" while powered by an external power source, such as the aircraft.

First, make sure NO batteries are in the unit. Reset power and try again. If low battery condition continues, unit needs to be serviced.

Traffic Detection

When tracking an aircraft flying overhead, ATC said traffic was less than a mile, but MRX indicated the traffic was 2.0 NM. Why the difference in range?

MRX gives range based on true distance in three-dimensional space and is based off of received signal amplitude. Some aircraft such as airliners have twice the power output of most general aviation aircraft and will appear closer than in reality.

Unit never detects traffic.

If your MRX unit never displays traffic and you suspect or can visually identify aircraft around you, your unit may need to be serviced.

A Note About ATC Services

While ATC can provide invaluable services to you as a pilot, using them to verify aircraft displayed on the MRX screen may be unreliable. Remember, MRX is an airborne, dual network system capable of detecting aircraft responding to TCAS interrogations, or aircraft that are out of reach of Ground RADAR. A rule of thumb is, if the MRX is displaying traffic, the traffic must exist somewhere. Nothing else can generate the unique squawk and altitude codes used in sensing traffic.

On the ground, during taxiing, or in the run-up, the unit starts displaying traffic at erroneous altitudes.

If you pass in close proximity to another aircraft either on the ground or when they are landing or taking off, MRX may momentarily receive their transponder altitude and think it is YOUR altitude. If this nearby transponder confusion occurs, the unit may display traffic below ground altitude or other traffic landing as too low or too high. This situation is self resolved as soon as your transponder transmits again, however it may be confusing until this occurs. To determine if another aircraft has set your altitude with their transponder, you would notice that the local altitude displayed is obviously higher than your ground level pressure altitude, and/or the squawk code may not agree with what your transponder is set to. Reset your MRX by turning it off, waiting at least two (2) seconds, then turning the unit on.

When tracking an approaching target, the range appears to decrease rapidly as if it is "catching up".

When transponder antennas are coated with oil, dirt or other materials, the transmission properties can change. We encourage all pilots to make sure their transponder antennas get cleaned as often as possible to reduce this affect of antenna-forward attenuation. This attenuation will cause a distortion in the ability to accurately detect traffic. MRX will be forced to accommodate for this attenuation by updating the range information when it can get a clear signal.

The unit constantly displays < 0.4 NM and "ALT +00".

Instead of ignoring your transponder, the unit is picking up your transponder as a threat. Try the following:

> Make sure your transponder antenna is clean. Even a small amount of grease or dirt build-up can dampen your transponder signal.

> Call Zaon and we can walk you through changing the local host transponder suppression level. This will allow MRX to "dig" a little deeper to lock onto your transponder. If this solution is not effective, you may need to contact a local avionics shop to test the power output of your transponder. The peak power output should be between 100 and 250 watts. Anything less is not acceptable under TSO tolerance, which is what MRX is calibrated to, and may not work with the MRX system.

Clean your transponder antenna often.

Displays constant traffic DETECTION; unit constantly displays > 0.9 NM.

Any traffic displayed can only be from another transponder-equipped aircraft. The only source for traffic detection is from other valid aircraft (unless the unit is detecting your own transponder, see above). In order for traffic to be displayed, MRX must decode a valid Mode C (altitude) signal code. Interference from your aircraft or avionics cannot create this code, and the pilot should trust this indication. It is not uncommon to see a consistent display of traffic within the detection window, especially when it is set to 6.0 NM as this is a large portion of airspace.

Common responses to constant traffic detection:

"I called ATC they said no traffic exists." This is an unreliable way of checking for traffic. ATC doesn't typically indicate traffic which is not a factor. This means there may still be traffic around you which MRX will detect. In addition, non-factor aircraft may not be displayed for ATC. For example, some controllers use a "1200 filter" which blocks all VFR traffic squawking 1200 from being displayed.

"I don't see any traffic and it says X.X NM" Traffic is typically not visible beyond 1 5 to 2.0 NM. Just because traffic can't be seen does NOT mean there is no traffic. First-time users may be surprised just how much traffic is nearby that was previously undetected. Again, MRX cannot display traffic unless a valid Mode C transponder code is detected.

"There can't possibly be someone at 5.0 NM for 10 minutes." Actually, this is very common. 5.0 NM may also indicates traffic is GREATER than 5.0 NM. Also, several aircraft may be within the 5-7 mile range. The only way for MRX to display traffic is to receive a valid code from another transponder.

These responses are typical for many pilots because they simply cannot SEE the traffic they assume it is not real. Pilots must learn to trust the instrument, similar to trusting flight instruments during instrument flying.

The local altitude displayed when I press "LOC" is different from my altimeter.

MRX displays pressure altitude, not indicated altitude. It is using the same format as your transponder. Indicated altitude will only match when your barometric pressure is 29.92". To test this, set your altimeter to 29.92. It should agree with your MRX within ±100 ft.

While flying, the local altitude displayed when I press "LOC" is significantly different from the current pressure altitude.

Check to ensure the pressure altitude was incorrectly computed. Check if the pressure has not changed since the calculation. If problem persists, the unit may need to be recalibrated. Call Zaon Customer Service for assistance.

Sometimes range information skips, for example, from 5.0 NM to 3.0 NM.

The transponder system on the target aircraft is not always transmitting; therefore this indicates the aircraft moved through 4.0 NM without transmitting for MRX to range it. Also, as an aircraft changes positions, antenna transmission lobes change, leading to signal alterations. This is normal.

When viewing an aircraft on takeoff, the unit did not detect the aircraft until it was airborne or at a certain altitude.

The aircraft was probably below RADAR coverage. Typically, once an aircraft has obtained an altitude of 300-500 feet AGL, it will be in coverage and start transmitting. Also, many pilots initially forget to switch their transponders to altitude. MRX, as with any other collision avoidance system, will not be able to detect an aircraft unless the target transponder is in altitude mode.

When the target aircraft taking off or landing, the unit indicates -100 or -200 feet which is not possible.

This is caused by the additive effect of the tolerances involved with the systems. A transponder system has a tolerance of ±100 feet. With two transponders involved (yours and theirs), as much as a ±200 foot variance may occur. These tolerances are FAA specified, and this situation applies for even the most complex TCAS systems.

The unit is alerting me and the aircraft is still 1.5 miles away.

Change modes to decrease threat levels and narrow the scope of what your unit will consider a threat.

The unit did not display any traffic or alerts when an aircraft flew by me.

MRX does not detect ALL aircraft. For example, if the target aircraft is out of RADAR range, does not have transponder on, or the antenna signal is shadowed, among other scenarios, MRX may not be able to display the traffic. Also, check that the altitude mode did not limit the detection window below the target aircraft's position. For example, if an aircraft passed 600 feet below, and the altitude window was set at 500 feet, no traffic would be displayed.

The range of some commercial airliners is displayed as closer than actual distance.

Airliners typically use a higher power transmitter which can affect ranging. While this difference is slight, it can be noticed at greater ranges where the power-to-distance envelope widens. For example, traffic at a true distance of 6 to 10 nm may be displayed as 4 to 6 nm. The closer the traffic is, the more this situation is cleared up. For example, traffic at 1 nm may be displayed as 0.8. This difference should be completely unnoticeable.

Appendices

Appendix A: Specifications

Environmental

Altitude	Min. 0 ft.	Max. 20,000 ft (FL200)
Temperature	Min. -20°C (-4°F)	Max. +55°C (+130°F)
Pressure	Min. 0 kPA (0 PSI)	Max. 100 kPA (14.5 PSI)
Humidity	Tested to 100% humidity	

Mechanical

Dimensions	4.2" (107 mm) 0.6" (17 mm) 2.6" (65 mm)	Length Height Width
Weight (without antenna)	3.75 oz. (106 g) 5.75 oz. (163 g)	Without batteries With batteries

Electrical

Power	12-40 VDC	Negative ground
Consumption	Internal battery @ 12V @ 28V	500 mW watt max. 1.2 watts max. 2.8 watts max.
Current	105 mA	
Connector Type	2.35mm mini	Tip positive

Receiver

Selectivity	1090 MHz 8.1 MHz	Receiver A Bandwidth
Signal Modes	X, Y, A, C, S, 2, 3/a	
Scan Rate	22 kHz	
Data Rate	1000 kbps	
MTL Sensitivity	-60 dBm	
Max Peak Power	+21 dBm	
Range Resolution	0-2.0 NM 2.0-5.0 NM	±0.1 NM ±1.0 NM
Max. Detection Range	50% Error Rate 10% Error Rate	7.0 NM 6.0 NM
Altimeter Accuracy	±200 ft.	
Receiver Dynamic Range	42 db	

Antenna

Weight	0.25 oz. (7 g)
Impedance	50 ohms
Polarization	Vertical Omnidirectional
Connector type	SMA RP

Display

Type	8-character super bright red LED graphic module
Maximum Brightness	2300 µcd per character

Storage

Temperature	Min: -40°C (-40°F)	Max: +85°C (185°F)

Battery Life

Remaining battery life is displayed by pressing the "LOC" button (pressing the nav switch to the left).

Battery Type	Tested Brand	Capacity (mAh)	Average Tested Duration*
Nickel-Metal Hydride	**Rayovac I-C3 15-minute**	**2000**	**7.1 hrs.**
Lithium	Energizer e2™ Lithium	2900	6.2 hrs.
Alkaline	Energizer™	2850	6.0 hrs.
Alkaline Mang Dioxide	Duracell®	2850	6.0 hrs.
Alkaline Mang (Supplied)	OEM	2850	5.8 hrs.
Carbon/Chloride	Not Recommended	925	N/A

* Average duration over 9 tests. Engineering tests were conducted in a controlled environment (70% humidity, 250 ft. MSL, 22-24°C) and subjected to an average amount of traffic detection. Tests were conducted from 11/15/05 through 12/2/05. Testing conditions will vary greatly and will change the outcome of your own tests. Conditions include amount of traffic, humidity, and temperature range, among many other factors.

Energizer and e2 are trademarks of Eveready Battery Company, Inc. Duracell is a registered trademark of The Gillette Company. Rayovac is a registered trademark of Rayovac Corp. Zaon Flight Systems, Inc. does not endorse any particular brand of batteries and is furnishing these test results on an informational basis only.

Accessories

A complete line of accessories is available from your local avionics or pilot supply store, or through Zaon direct.

Appendix B: Customer Service

Before contacting your place of purchase for a repair or refund, call us directly. In most cases, any concerns can be satisfactorily remedied by one of our technicians or support staff.

Online Support

Web Address	Description
Register Your Unit www.zaon.aero/register	**Please register your unit with Zaon Flight Systems.** This will keep you up-to-date with changes or revisions. Also, no repairs or warranty work will be performed on unregistered units.
Avionics Web Site www.zaon.aero	All information on Zaon avionics can be accessed from our avionics home page. Start here for most of your questions or information needs.
KnowledgeBase www.zaon.aero/support	An extensive database of articles has been established on the internet to assist with a variety of questions and concerns, from installation and operation to detection concerns and expectations. Before contacting us personally, we urge to you search the database for answers to many of your questions.
Firmware Updates www.zaon.aero/firmware	This site contains all information concerning the latest firmware releases for all of our products, including information on how to obtain a firmware update.
Accessories www.zaon.aero/accessories	Should you need to order or replace any avionics accessories, please visit the XRX accessories page. This page keeps you current with the latest accessories for your XRX.

Personal Support

For personal support or technical questions, please call Zaon Monday through Friday, 9 am to 5 pm Central, at:

- > Toll-Free **(800) 496-9430**
- > International **+1 (469) 916-6640**
- > Fax **(469) 916-9939**
- > Email **support@zaon.aero**
- > Visit **www.zaon.aero**

Appendix C: Firmware

Current Version: 2.9 (1.9 for non-installed systems)
As of 9/2007. Refer to the Firmware Updates website for the most up-to-date information

Upgrading the Firmware

Your XRX unit can be reprogrammed to accept future firmware updates. The current firmware number will be displayed during the startup sequence (i.e. 1.0). For the latest firmware version, or for instructions on how to get your firmware updated, please visit the Zaon website at **www.zaon.aero/firmware**.

Firmware updating may require you to send in your unit to the factory for reprogramming and recalibrating.

Firmware Change History

Version 2.9

> User can now select ground or flight mode during startup sequence

Version 2.8

> Unit now indicates when in ground mode in traffic page

Version 2.7

> Updated alert parameters for 5NM range: advisory at 1.5NM, alert at 0.9NM
> Updated local transponder page to display "ALT" if altitude is from internal altimeter, "TRA" if from transponder

Version 2.6

> Reduced volume baseline

Version 2.4

> Changed altitude threshold for local host to +/-700 ft. allowable tolerance
> Added Batter Life Indicator (in both startup and "local" sequences)
> Minor temperature and traffic algorythm update

If unit is to be installed, an upgrade to 2.4 or higher is necessary. Units with version 1.9 or lower should not be installed. Contact Zaon for more infromation.

Version 1.4 - 1.9

> Matches 2.4 - 2.9 changes for non-installed systems

Version 1.3

> Changed Low Bat threshold

Version 1.1 to 1 2

> Corrected pressure altimeter issue when pressure altitude is sea level or lower
> Corrected pressure altimeter issue to prevent skips in calibration steps in admin menu
> Corrected audio problem for alerts issued at a specific relative altitude
> Revised ranging algorithms in 0.1NM to 0.9NM fields

Version 1.1

> Changed default altitude 2000 feet
> Revised pressure altitude / thermal auto adjustment

Initial Release: 1.0 (12/2005)

Appendix D: Warranty Information

One-Year Limited Warranty

Zaon Flight Systems, Inc. ("Zaon") warrants PCAS Model MRX ("Product") (including any standard, included accessories) with the following conditions:

WHAT THIS WARRANTY COVERS: This warranty covers all defects in material or workmanship with the following definitions. LABOR: For a period of 12 months from the date of purchase, if this Product is determined to be defective, Zaon will repair or replace the Product, at its option, at no charge. PARTS: In addition, Zaon will supply, at no charge, new or rebuilt replacements in exchange for defective parts for a period of 12 months.

WHAT THIS WARRANTY DOES NOT COVER: This warranty does not cover customer instruction, installation, set up adjustments or signal reception problems caused by anything other than internal component malfunctions as specified above. This warranty does not cover cosmetic damage or damage due to acts of God, accident, theft, misuse, abuse, negligence, commercial use, or modification of, or to any part of the Product, including the antenna. This warranty does not cover damage due to improper operation or maintenance, connection to improper voltage supply, or attempted repair by anyone other than an authorized Zaon facility. This warranty does not cover Products sold AS IS or WITH ALL FAULTS, or consumables (such as batteries). This warranty is valid only in the United States. REPAIR OR REPLACEMENT AS PROVIDED UNDER THIS WARRANTY IS THE EXCLUSIVE REMEDY OF THE CONSUMER. ZAON SHALL NOT BE LIABLE FOR ANY INCIDENTAL OR CONSEQUENTIAL DAMAGES FOR BREACH OF ANY EXPRESS OR IMPLIED WARRANTY ON THIS PRODUCT. EXCEPT TO THE EXTENT PROHIBITED BY APPLICABLE LAW, ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE ON THIS PRODUCT IS LIMITED IN DURATION TO THE DURATION OF THIS WARRANTY. In no case will Zaon be held liable for direct, or incidental damages resulting from any defect or omission in the Owner's Manual or other related items and processes, including, but not limited to service, loss of business, anticipated profit, or other consequential damages. This warranty is invalid if the factory applied serial number or original case seals have been altered or removed from the Product. Some states do not allow the exclusion or limitation of incidental or consequential damages, or allow limitations on how long an implied warranty lasts, so the above limitations or exclusions may not apply to you. In addition, if you enter into a service contract with Zaon within 36 months of the date of sale, the limitation on how long an implied warranty lasts does not apply to you. This warranty gives you specific legal rights, and you may have other rights which vary from state to state. The remedies herein shall be cumulative and additional to any other or further remedies provided in law or equity.

ZAON MAKES NO WARRANTIES, EXPRESS, STATUTORY, IMPLIED OR OTHERWISE, OTHER THAN AS EXPRESSLY SET FORTH HEREIN. ZAON EXPRESSLY DISCLAIMS THE IMPLIED WARRANTIES AND CONDITIONS OF NON-INFRINGEMENT, MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, TO THE MAXIMUM EXTENT PERMITTED BY LAW.

Opening your avionics unit voids this Warranty. There are no user-serviceable parts inside your MRX unit. Opening the unit will change the individually-tuned internal circuitry and WILL VOID YOUR WARRANTY COVERAGE.

To Return Your Unit For Repair

If you purchased MRX from a Zaon dealer, do not contact the dealer for repair. All repairs must be completed through Zaon directly. To return your XRX for repair, call us to receive a Returned Merchandise Authorization (RMA) number, return questionnaire and shipping instructions. **No repairs or refund will be made without an RMA number.**

To Return Your Unit For A Refund

Units must be returned through the place of purchase. Shipping costs for all returns hereunder shall be at buyer's

expense.

Register Your Unit

Please register your unit with Zaon Flight Systems. This activate your product warranty and will keep you up-to-date with changes or revisions. No repairs or warranty work will be performed on unregistered units.

If the original registration card is missing from your unit, register online at **www.zaon.aero/register** or use the card below. Either cut out or photocopy this page and mail the completed card to:

Zaon Flight Systems, Inc.
15946 Midway Road
Addison, TX 75001

Registrat
Form

WHY REGISTER?

Warranty Service Protection

No warranty service will be performed on unregistered units

Firmware Update Notices

Keep informed of new updates for your PCAS and when new products are available

Save A Stamp!

Register online at http://register.zaon.aero

NAME First Name M.I.

Last Name

ADDRESS Street

Number | Suite ZIP | Postal Code

City State | Prov.

Phone Country

Email

Would you like to receive product updates and news via e-mail?
We do not provide your e-mail address to other parties. Yes No

PRODUCT Store or Dealer Name Direct from Zaon

Date of Purchase Serial Number
Located on bottom of unit

Appendix E: Installation & The FAA

Installation Kits

Installation kits are available to allow your MRX to be installed into your instrument panel. Contact Zaon directly for installation kit details.

FAA Certification

MRX is a Class 1 EFB device and does not require FAA, AIR or AEG evaluation or certification for normal, portable use. No FAA approval is needed if used in a Sport or Experimental aircraft class. However, if you plan to install MRX into a certificated aircraft, you may need the installation to be approved by your installer as a minor alteration or a major alteration at his/her discretion, and/or your local FAA Flight Standards Field Office (FSDO). If approving the installation of this unit through the local FSDO, a Form 337 Field Approval Application must be completed for your particular aircraft and approved by the FAA to be in full compliance. Zaon is unable to offer assistance with this procedure at this time for Model MRX.

Appendix F: Regulatory Information

FCC Regulations

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed in accordance with the instruction manual, may cause harmful interference to radio communications.

Canadian Regulations

This Class B digital apparatus meets all requirements of the Canadian Interference-Causing Equipment Regulations. (Cet appareil numérique de la classe B respecte toutes les exigences du Réglement sur le materiel brouilleur du Canada.)

European Economic Community Declaration of Conformity

According to ISO/IEC Guide 22 and EN 45014

Manufacturer's Name: Zaon Flight Systems, Inc.

Manufacturer's Address: 15946 Midway Road, Addison TX 75001 USA

declares that the product

Product Name: PCAS
Model Number: MRX
Product Options: None

conforms to the following product Specifications:

The EMC Directive 89/336/EEC*
Emissions: Harmonized CISPR Standard EN 55022
Meets or exceeds RTCA DO-138 Category B
Immunity: Harmonized Basic Standard EN 50082-1

The product herewith complies with the requirements of the EMC Directive 89/336/EEC of the European Community and carries the CE marking accordingly.

* The product was tested in a typical usage configuration.

Zaon Flight Systems, Inc.
Office of Quality Manager
Addison, TX
November 2005

European Contact: Sky Fox GmbH, Pfalzburger Str. 43-44, Berlin, Germany (Fax 49 30 864

Index

Table Index

My Information

Serial Number

5-digit number found on label on bottom of unit _____ _____ _____ _____ _____

Purchase Date

_____ Month _____ Day _____ Year

Dealer

_____

[ ] Direct through Zaon

Firmware Revision History

Date	Version
Shipped	

To keep up-to-date:

www.zaon.aero

For technical questions:

support@zaon.aero

Notes