Weather Avoidance Equipment and the PC12

By John Morris

Since the last article I wrote dealt with the Nexrad System, and the on-board Radar not working, I felt it only appropriate to now write about the available, *working*, weather avoidance equipment, including indicators and controls, as well as their functions as they relate to the PC12.

There are two types of standard weather avoidance equipment for the PC12. The first is the RDR 2000*, which was introduced to general aviation the same year as the PC12 (1994) but not installed until 1997. The RDR 2000 is comprised of the ART 2000, an X-Band transmitter/receiver with Vertical Profile, the 182VP (display) indicator and the CP466A (See pictures). The other piece of standard equipment is the MRK1 **E**stimated **Y**onder **E**ncounter **B**y **A**rea, **L**at/Lon, and **L**ightning **S**ystem (aka-Eyeballs).

The RDR 2000 has a power output of 4kw maximum, 3.5kw nominal, with a stabilized 10"- slotted array, flat panel antenna. A 12" antenna is available but not for the PC12.

What is the importance of the power output and antenna size? The power basically determines the range that precipitation can adequately be detected through the receiver, called reflectivity. It is measured as a form of noise, in dBZ, and is equal to the beam width and power level. The antenna size determines the beam width and directivity, which determines the angular measurement accuracy. Hence, the larger the antenna the smaller the bandwidth and the better the signal-to-noise ratio (distance-attenuation recognition) See **Table 1**.

Table 1

	Range	Power
RDS 82VP	10-240 NM	1kw
RDR 2000	10-240 NM	4kw (3.5nominal)
RDR 2100	5-320 NM	6kw
Primus 440	2.5-200 NM	10kw
Primus 660	2.5-300 NM	10kw

Wonder why the Primus 660 has longer range than the 440 when they both have the same power? Larger available antenna-18” versus a 10” or 12” for the 440.

The stabilized flat panel type antenna has become more commonly used in aviation, since the antenna size goes to 24”, while the parabolic dish type is still in use by the commercial operators because of larger diameter. Both antennas have the same type of directional beam, called a pencil beam, where the major portion of the output power, more than half, is emitted. This portion of the beam is called the main lobe.

Reflectivity works within the X-Band frequency to detect precipitation or objects more dense than water. Attenuation is when the radar pulse is absorbed or scattered before it can return to the antenna. The main causes of this effect are heavy precipitation and distance. X-Band is used primarily because of its narrow frequency bandwidth, which is very useful for directional purposes and resolution, but it is comparatively weak when it comes to attenuation. This means that it cannot “see” far into heavy precipitation, or possibly beyond the heavy precipitation, called the shadow effect. To compensate for distance effects, the RDR 2000 has Sensitivity Timing Control (STC) circuitry, which works best at 40NM or less. For more details please review your RDR 2000 Pilots Guide about this and other related functions.

A stabilized antenna means that the AHRS is used to maintain the antenna's ordination to the horizon while turning or pitching no more than 20º. This includes the tilt angle the antenna is set to prior to maneuvers.

Tilt angle of the antenna is very important for weather detection/avoidance, especially at lower altitudes. We need to understand how much tilt will be required to properly detect weather versus ground clutter (too low-tilt) or not detecting weather (too high-tilt). While climbing or descending, the stabilized radar will sweep the horizon based on the tilt angle. Generally that means that at takeoff the tilt should be near + 6 (according to Honeywell's radar training DVD) and then continually reducing the tilt as we climb, until reaching a cruise flight level where it may be necessary to have a negative tilt selected. The reverse will be true when starting a descent through landing. **Table 2** shows the approximate height/distance at which the radar will detect ground returns base on antenna size.

Table 2

Beam Width	10º	8º	5.5º
Antenna Size	10”	12”	18”
5000’	7	10.5	12
10,000’	19	24	33
15,000’	28	36	50
20,000’	36	49	72
25,000’	48	60	92
Approximate distance from antenna to (flat) surface: 0º Tilt and Stabilized (NM)			

Also included in the RDR 2000 is the Vertical Profile (VP) feature. This scans a vertical “slice” of weather to an angle of ± 30°. When selected, the profile shows the height of the weather in thousands of feet, based on the range selected. The </>Track buttons will move the slice 2° per push. Of course the radar is still sweeping horizontally so there is a slight delay before a vertical return update. Again, the tilt angle will affect the display results.

<u>Optional Weather Avoidance Equipment</u>

The Nexrad System
Lightning Detection Systems

The Nexrad system is supplied and operated by the government and is available/reproduced by Honeywell, XM and Avidyne.

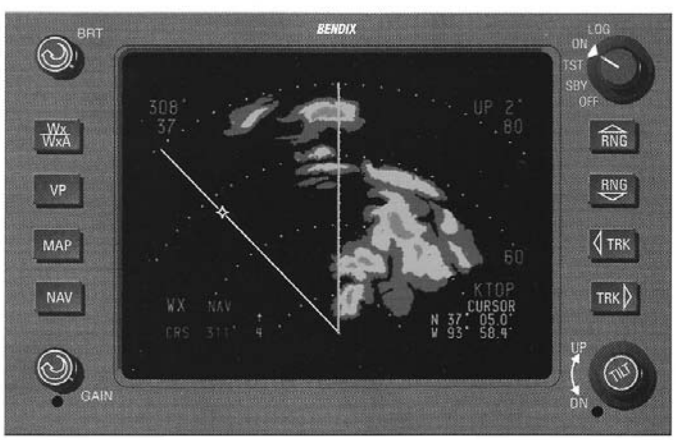
The Lightning Detection Systems (LDS) available are Insight Strike Finder, Stormscope and the National Lightning Detection Network.

1. Strikefinder is installed as a stand-alone display.

2. Stormscope/L3 can be installed as a stand-alone display or integrated into the EFIS, Radar Indicator, MFD or Garmin 430/530 displays.

3. The National Lightning Detection Network is a commercial venture that supplies cloud-to-ground only lightning detection, to subscribers nationwide using triangulation from sensors installed throughout the country (See map). This can be offered along with a Nexrad subscription in-lieu of installing a dedicated Lightning Detection System.

<u>Control Panels/Indicators/Multi-Function Displays</u>



182A VP

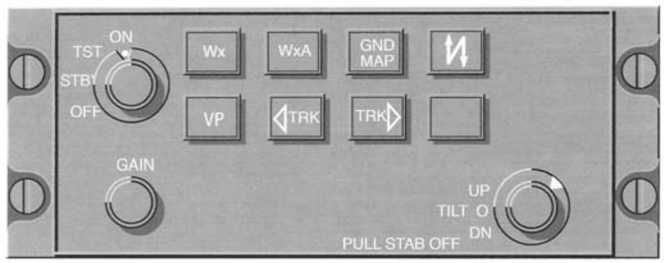


Figure 2.3.1
CP 466A

When the PC12 started production in 1994 the only available Radar Indicator was the EFIS 40 with the CP466A control panel (which has integrated LDS and VP capability, but LDS not approved yet).

Beginning in 1996, the 182A display was added as an option to the EFIS 40, which had the control panel buttons included (without LDS/VP capability) along with the CP 466A. Note: The EFIS 40 MFD is the same display as the EFIS 40 EHSI except for a specific configuration for Vertical Profile that the pilot/co-pilot EHSI will not have.

In spring 1997, the installation of the RDR 2000 began, along with the Stormscope WX-1000E (usable only through the EFIS 40 EHSI or MFD).

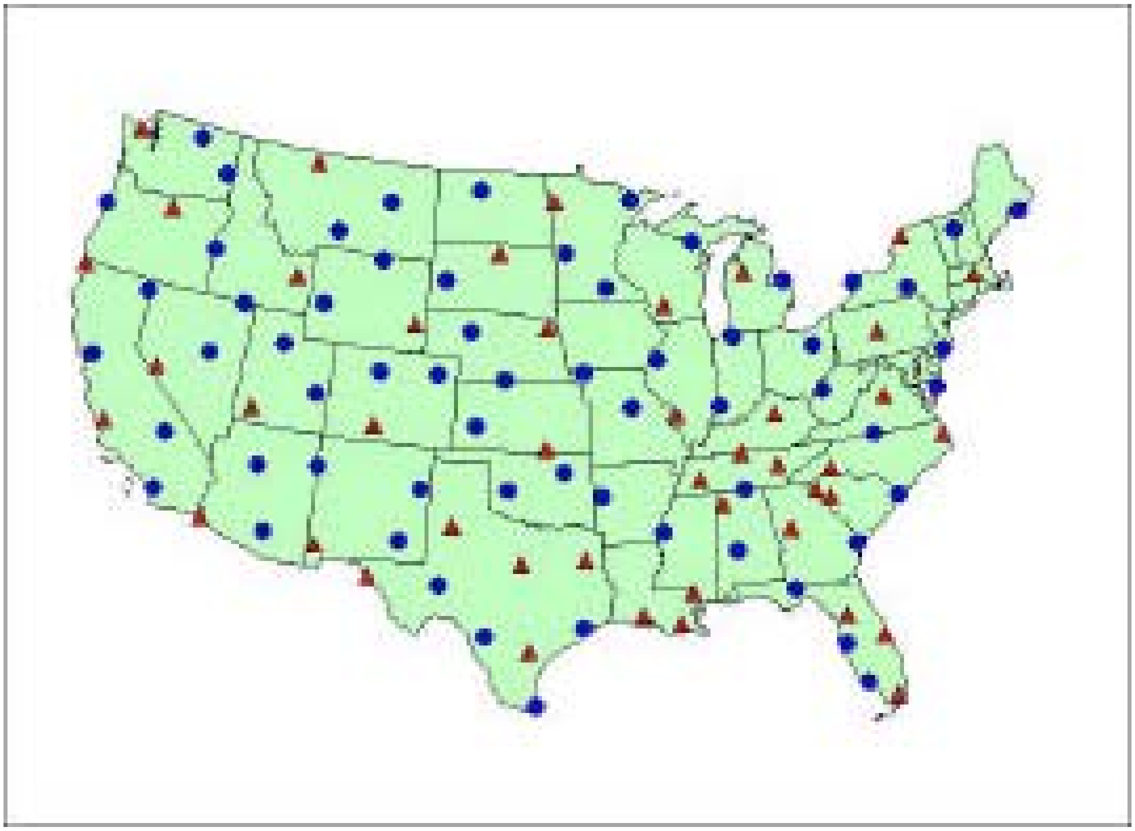
In summer 2001 the KMD 850 became the standard display for the radar, with the option of retaining the CP466A for additional radar information on the pilot's EHSI. See **Table 3** for more information regarding displays and their associated functions.

Table 3

MFD Displays	VP	LDS	Nexrad
KMD 850	Y	Y[1-2]	Y[2]
Garmin 430/530	N	Y[2-3]	Y
Avidyne EX-500	Y	Y[1-2]	Y[2]
Garmin GMX 200	N	Y[1-2-3]	Y[3]
Garmin MX 20	Y	Y[1-2-3]	Y[3]
EFIS 40/50	Y	Y[4]	N
182A	Y	Y[4]	N

1. L3/Stormscope WX-500 only
2. LDS through Nexrad subscription cloud-to ground only (possible 5 minutes between updates).
3. Will not display LDS unless range is 25nm or >
4. Stormscope WX-1000E only. If pilot/co-pilot EHSI will not display VP and must have CP466A for other weather functions.

* The 1st Radar installed in the PC12 was the RDS 82VP. It uses the same 182A Indicator (without a VP button) and the CP466A control panel. The only other item different was 1kw power output rating.



The National Lightning Detection Network Map

Summary of Operations

The rated range of the RDR 2000 is 240NM. Based on my operating experience with this unit I have found the best maximum range to be 80NM, which from research appears to be the normal range for most GA aircraft until using larger (more power/size) systems. This gives adequate time to make decisions, since the PC12 is not going that fast (avg. 4.2 miles per minute-cruising). I have seen on more than one occasion where a continuous "light return" at the 80nm range turned into something much stronger when within the 40nm range of the radar. And I have seen the reverse happen as well from 80nm to 40nm on the RDR 2000. That is why I only use 80nm as my maximum and shift to the lower ranges when suspecting *any* continuous returns.

As for tilt operations I generally go by the following:

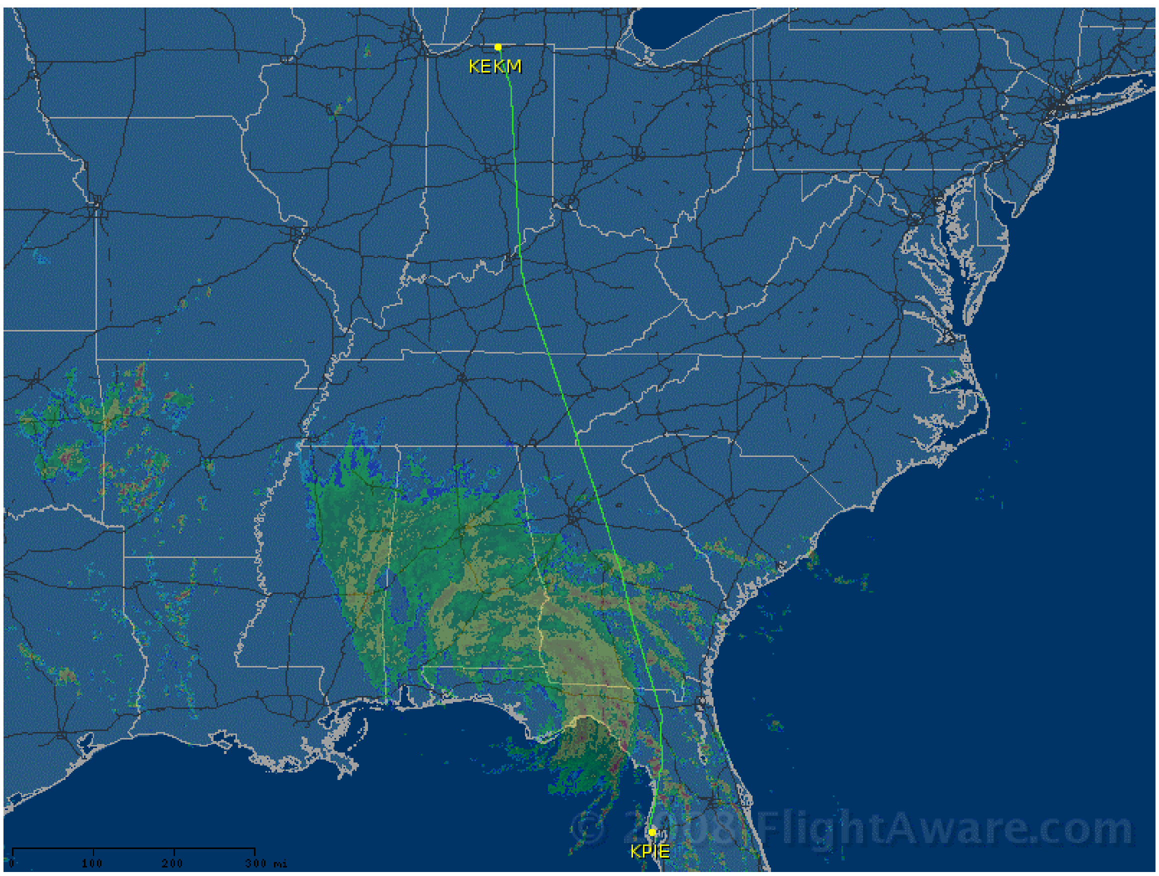
<u>Antenna Stabilized</u>

1. Takeoff - +4°
2. Cruise - +1.5° - 2° [Looking for cruise altitude Tops]
3. Descent - +2°- 4°

It should be noted that wind correction is not adjusted for the radar. The track line feature, using the track buttons for the VP, if available and operational, will draw a line for the approximate aircraft radar center. It is up to the pilot to know the wind correction, in order to draw the track line. It does not reposition the radar.

Just prior to writing this article I flew from St. Petersburg, FL to Indiana flying around the backside of Tropical Storm Fay. At FL 270-280 I was IMC for most of the first 2 hours-MRK1's mostly inop (See track). If operating by the Nexrad only, I would not have flown this trip. However, pre-flight briefing and using the RDR 2000 plus Nexrad/LDS, the flight was un-eventful with the greatest threat being my initial vector after takeoff from KPIE (west) towards some nasty cells. However, as previously discussed, Tampa has the TDWR, and they turned me away before I was about make a turn myself, since my MRK1's were getting large. 95% of the "red" was below my cruising altitudes by several thousand feet. Using the cruise tilt settings helps to ensure that the tops are not at my altitude. Of course, when in doubt, go-around or away!

As always, the safest IFR pilot is the one who makes the correct decision <u>before</u> the flight begins. Do I really need to go? There should never be a *real reason* to go, only an informed, smart, safe decision to proceed with options.



I have a request.

As you have probably surmised, I really love the PC12 and enjoy flying, instructing and writing about it. I am always

looking for anything relating to PC12 systems/operations and safe flight to talk/write about. If you have any requests, questions or comments relating to my current articles or future articles, systems, training, or flying in general, please fly by my website www.acftservices.com and contact me.
Thank You

“A Safe Pilot is Always Learning”

John Morris
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