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DOCUMENT TITLE

RADIO NAVIGATION

CHAPTER 10 – RADIO ALTIMETER

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CHAPTER 10: RADIO ALTIMETER

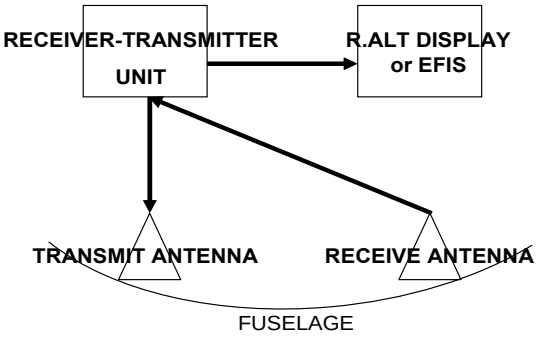
PURPOSE OF THE RADIO ALTIMETER

A radio altimeter is an instrument used to measure height above the terrain, normally in the range 0 to 2500 feet. Altitude above the terrain may be referred to as height agl (above ground level) or as absolute height.

The radio altimeter is used to provide accurate information to the pilot about aircraft height agl during the approach and landing phases of flight. It is also an important input to the aircraft's GPWS (Ground Proximity Warning System) and to the auto-pilot/flight control computer.

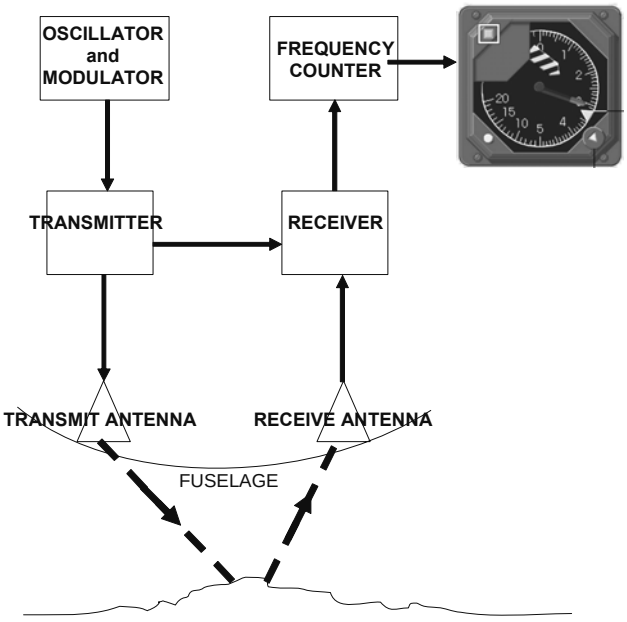
RADIO ALTIMETER SYSTEM

The radio altimeter is self-contained and needs no ground facilities for its operation. The system consists of the receiver- transmitter unit, the indicator and separate transmit and receive aerials.



The aerials are down-ward looking and are mounted on the underside of the aircraft in such a way that the receiving aerial is shielded from the transmitter.

PRINCIPLE OF THE RADIO ALTIMETER



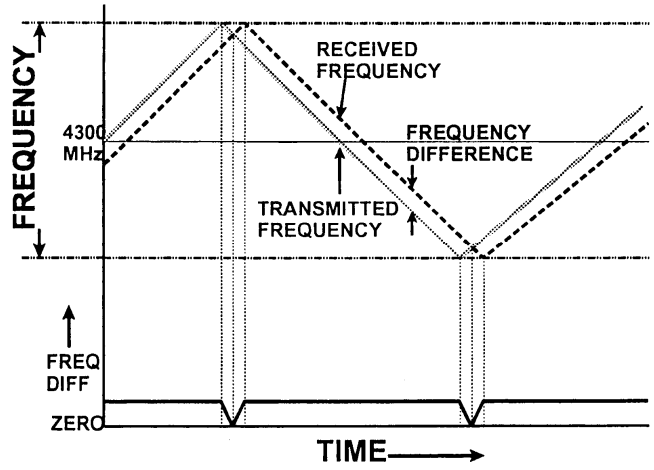
The radio altimeter measures the amount of time taken for the radio signal to travel from the aircraft to the terrain and back again.

Because radio waves travel at a known speed, the height of the aircraft can be calculated. To measure this time, the radio altimeter varies its transmitter frequency at a fixed rate. The result is that the received frequency is different to the frequency currently being transmitted.

Note: the best surface reflector is water and the worst is dry soil.

RADIO ALTIMETER OPERATION

Radio altimeter transmissions are described as FMCW (Frequency Modulated Continuous Wave). A typical altimeter generates a CW signal of 4300 MHz ± 50MHz. A sample of the transmitter frequency is passed to the receiver and as time has elapsed since the received signal left the transmitter, a difference exists between the frequency of the received signal and the frequency currently being transmitted.



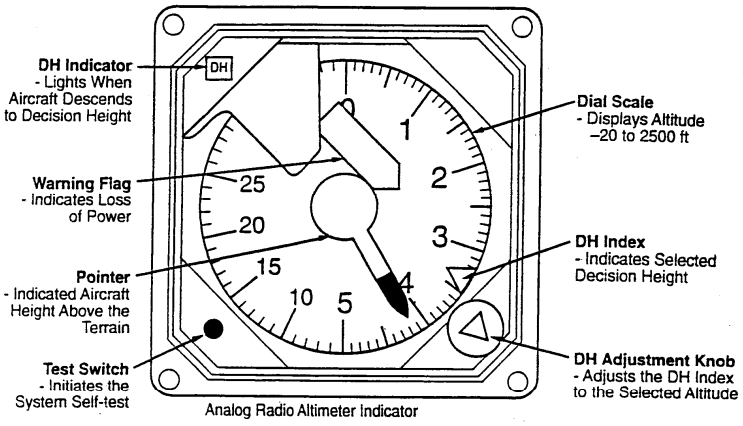
Radar Altimeter height calculations can be made using the following two formula

1. **t = Δf/modulation rate**

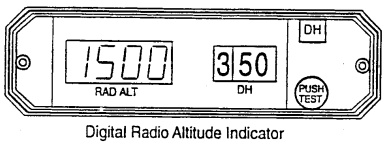
2. **Height = (Cxt)/2**

RADIO ALTIMETER DISPLAYS

A typical indicator displays height -20 to +2500 feet and has annunciators that display decision height and failure flags.

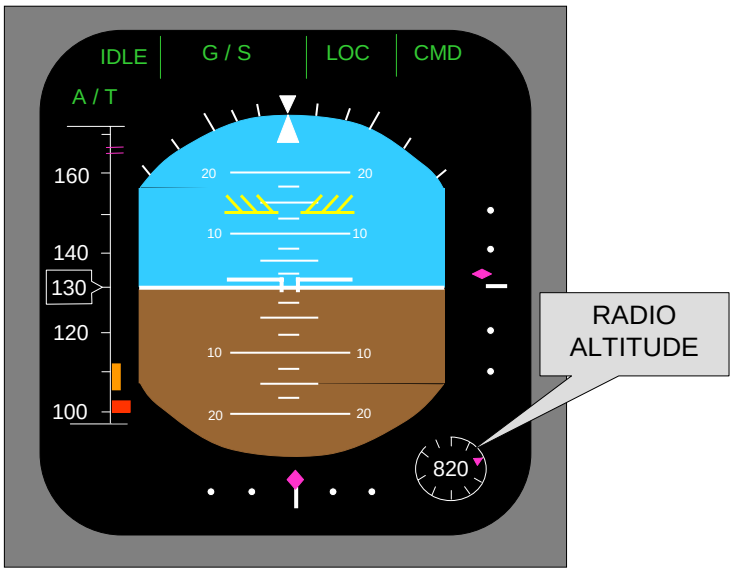


Analog Radio Altimeter Indicator



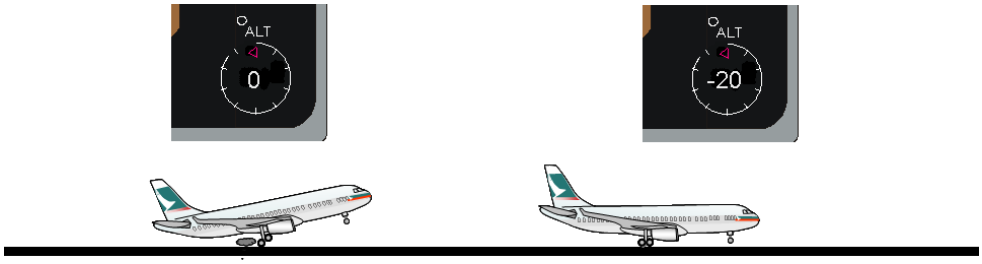
Digital Radio Altitude Indicator

On EFIS (Electronic Flight Instrument System) equipped aircraft, radio altitude is shown on the primary flight display. Height is shown digitally and may also appear graphically as a rising runway symbol.



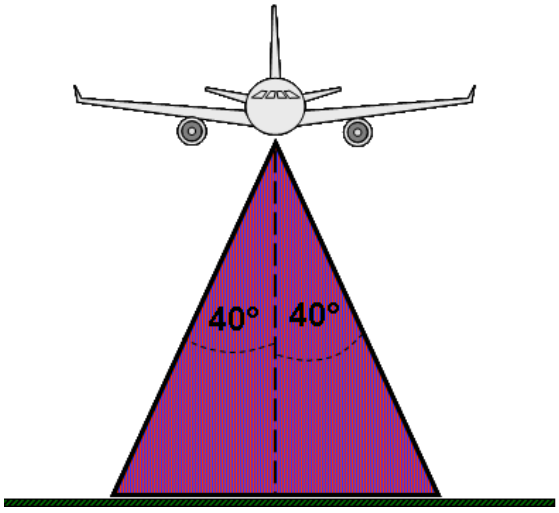
CALIBRATION

It is desirable for the radio altimeter to read 0 feet at touchdown. Compensation is made for the height of the aerials above the main gear in the landing attitude.



Compensation is also made for the delay caused by the length of the coaxial cables. Note that after landing, a negative figure may be displayed.

PITCH AND ROLL LIMITS



The radio altimeter transmits an elliptical cone of radio energy so permitting accurate readings to be obtained during manoeuvres. A typical radio altimeter permits angles of pitch to about 25° and angles of roll to about 40°.

ADVANTAGES OF THE RADIO ALTIMETER

1. The radio altimeter provides height above ground level and its readings can be used directly for the purposes of terrain clearance.
2. The radio altimeter can be used to cross check the pressure altimeter if the height of the terrain is known.
3. The readings of the radio altimeter are highly accurate (±2 feet or 2% from 500 feet to touch-down)
4. The radio altimeter provides an essential input to other system, such as GPWS and Autoland.

THE RANGE OF THE RADIO ALTIMETER

Range is usually limited to -20 feet to + 2500 feet but some equipment operates to 5000 feet.

WORKSHEET – RADIO ALTIMETER

1. Which of the following would be a typical wavelength of a radio altimeter?
   a) .7 metres
   b) 6.9 cm
   c) 7 metres
   d) 69 metres

2. Modern radio altimeters operate in the _____ frequency band using _____ to measure height above the terrain.
   a) UHF phase difference
   b) SHF frequency modulation
   c) SHF pulse technique
   d) UHF pulse modulation

3. The strongest return signals will be obtained from:
   a) water
   b) snow
   c) heavily foliated areas
   d) dry, fine, loose soil

4. The reading on the radio altimeter may be negative. This is most likely to be the result of:
   a) delay caused by the use of long lengths of coaxial cable in the installation
   b) inaccuracy due to transmitter frequency instability.
   c) a landing at an airport below sea-level.
   d) compensation for the height of the antenna above the landing gear.

5. As aircraft height above terrain increases, the difference between the received and transmitted frequencies will:
   a) increase
   b) decrease
   c) remain constant
   d) increase or decrease depending on the phase of the frequency modulation.

6. The radio altimeter may be conveniently used to:
   (i) feed height information to the autoland system
   (ii) check the accuracy of the pressure altimeter, provided the height the ground is known.
   (ii) maintain level flight
   Which of these statements are true?

   a) All are true
   b) (i) only is true
   c) (i) and (ii) only are true
   d) (ii) and (iii) only are true

7. If the elapsed time measured by the radio altimeter between the transmitted and received signal is 936 nano-seconds, what will be the radio altimeter reading (absolute altitude)? The aircraft is flying over a surface with elevation 210 feet.
   a) 280 feet
   b) 460 feet
   c) 670 feet
   d) 920 feet

8. The accuracy of a typical radio altimeter reading 300 feet is:
   a) ± 2 feet
   b) ± 6 feet
   c) ± 10 feet
   d) ± 20 feet

9. Which of the following systems does <u>not</u> use radio altitude?
   a) TCAS
   b) GPWS
   c) AUTOLAND
   d) WEATHER RADAR

10. The cone-type antennas used by radio altimeters ensure that signals will continue to be received typically to a bank angle of approximately:
   a) 0° -10^0
   b) 10° - 15^0
   c) 40^0 - 60°
   d) 60^0 - 90°

11. The elapsed time between the transmitted and received signal is 467.9 nano seconds. Determine the aircraft's absolute height.

   (a) 460.41 ft
   (b) 230.21 ft

(c) 140.37 ft

12. A radio altimeter is frequency modulated at 35 Hz per nano second. The change in frequency between transmission and reception is 27.8 kHz. Determine the height of the aircraft above ground.

(a) 390 ft
(b) 620 ft
(c) 500 ft

13. A radio altimeter has a modulation rate of 30 Hz per nanosecond. The receiver frequency is 4310.2200 MHz when the transmitted frequency is 4310.2000 MHz. What is the height of the aircraft.

(a) 420 ft
(b) 540 ft
(c) 330 ft