PRESENTATION

Relative Bearing Indicator (RBI)

On the RBI indicator (left) the aircraft is heading 360° (we assume the card is aligned with the directional heading of the aircraft) and the station is 60° to the left. This means the relative bearing is 300°.

Radio Magnetic Indicator (RMI)

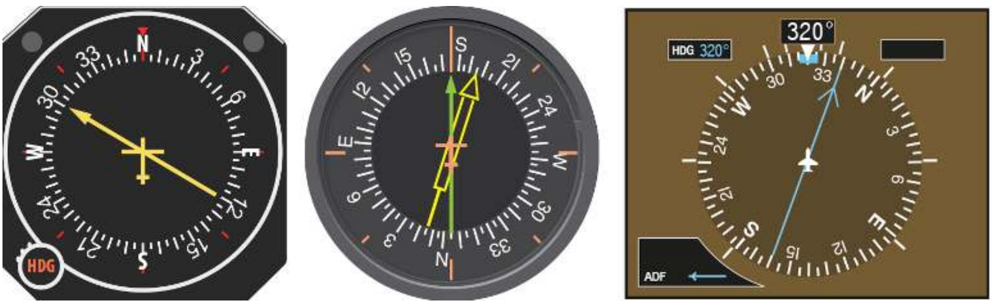
On the RMI indicator (center), the aircraft is heading 175°. The information is still relative, so the bearing shown is the magnetic bearing of the NDB (195°). The relative bearing will then be 20°.

The needle will always point TO the station (QDM) and the tail of the needle will then give you the QDR.

Electronic displays

On the digital presentation (right), the card will follow just as on a RMI.

On this indicator, the aircraft is heading 320° and the relative bearing is 20°.



Left: The RBI (Relative Bearing Indicator). Center: The RMI (Relative Magnetic Indicator)
Right: Digital presentation

HOMING

The ADF may be used to "home" in on a station. Homing is flying the aircraft on any heading required to keep the needle pointing directly to the 0° RB position.

To home in on a station, tune the station, identify the Morse code signal, and then turn the aircraft to bring the ADF azimuth needle to the 0° RB position.

Turns should be made using the heading indicator. When the turn is complete, check the ADF needle and make small corrections as necessary.

VOR

THE VOR GROUND EQUIPMENT

VOR means *VHF (Very High Frequency) Omnidirectional Radio Range*.

The frequency band allocated to VOR will be found in the VHF-band. The frequencies used are from 108 to 117.975 MHz.

This again is split up so that the ILS system has its own band from 108 to 111.975 MHz. They will always start with an odd number after the first decimal place, e.g. 111.90 MHz.

They VOR station transmits 360 *radials*, meaning that we can find out where we are relative to the station by adjusting our instrument.

ATIS may also be transmitted on VOR frequencies.

We have two types of VOR stations, the CVOR and the DVOR.

CONVENTIONAL VOR (CVOR)

The CVOR is the first-generation VOR station. It is emitting signals by means of a rotating antenna.

DOPPLER VOR (DVOR)

The DVOR is the second-generation VOR station. It is emitting signals by means of a combination of fixed antennas utilizing the Doppler principle.

A DVOR station

DISTANCE MEASURING EQUIPMENT (DME)

GENERAL

A DME is used for determining the distance from a ground transponder (the DME station). Compared to other VHF/UHF NAVAIDs, a DME is very accurate. The distance information can be used to determine the aircraft position or flying a track that is a constant distance from the station. This is referred to as a DME arc.

The DME system operates in the UHF band. The frequencies however, are paired with the VOR or ILS frequencies. So the frequency you set on your DME is the same as on your VOR/ILS-receiver.

Identification is done in the same way as for the VOR and NDB. The DME will present itself every 40 seconds.

The system comprises two basic components:

The *interrogator*, in the aircraft.

The *transponder*, which is the DME station on the ground.

Military TACAN stations can also be used for DME information for civil aircraft.

The DME can also be used to plot a position on a map as a point on a circle. With the help of another DME station, the position can be plotted quite accurately - and RNAV systems does this for you.

FREQUENCIES

The *interrogator*, is transmitting on frequencies from 1025 to 1150 MHz.

The *transponder* is transmitting on frequencies from 962 to 1213 MHz.

The difference between the frequencies from the interrogator to the transponder is 63 MHz whereas the higher frequency is used by the interrogator.

THE PRINCIPLE

DME signals are line-of-sight; the distance readout is the straight line distance from the aircraft to the DME ground facility and this is commonly referred to as slant range distance.

This is excellent when flying an ILS approach, but can present some issues otherwise: If you cross the station at 6080 feet and 0 NM ground distance, the distance indicated will be 1 NM. This is known as slant range error.

Slant range error is negligible if the aircraft is 1 NM or more from the ground facility for each 1,000 feet of altitude above the elevation of the DME station.

The DME can also calculate your ground speed and time to station, as long as you approach the station **directly**. This function will not be usable when you e.g. fly the DME arc.

CALCULATING THE GROUND DISTANCE

We are flying at 10.000 ft AGL and we are indicating a slant range (distance) of 5 NM to the DME station (as on the illustration below).

First we have to calculate our altitude in NM by dividing it by 6080 (1 NM).

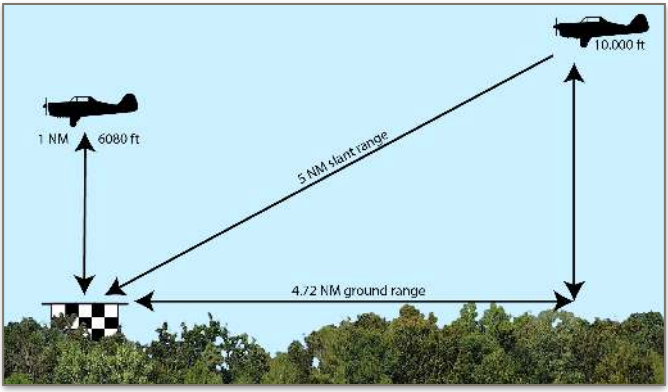
10.000/6080 gives us **1.64 NM** of altitude.

Then some Pythagoras to calculate the ground range:

$5^2 = 1.64^2 + X^2$

$X = \sqrt{25 - 2.68}$

This gives us 4.72 NM ground range.



Slant range distance vs ground distance

COVERAGE AND RANGE

A modern DME station can receive a maximum of 2700 pulses (interrogations) per second. This corresponds to up to 100 aircraft at a time.

The closest aircraft to the station will get replies more often and thus priority.

The aircraft further away from the station will be denied first (when the station is saturated with interrogations).