Testing of DME/TACAN Ground Stations

Application Note

Product:

- R&S®EDS300

This Application Note describes the basic operating principles of distance measurement equipment (DME) and tactical air navigation (TACAN) for distance and bearing measurements in aviation along with diverse test possibilities for maintenance of DME/TACAN ground stations.

Some tests can be performed on the ground while others require flight inspection. Both types of tests can be performed with the R&S®EDS300 DME/pulse analyzer.

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Testing of DME/TACAN Ground Stations

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5.2015 – 1EF91_1E

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1 Introduction

Avionics is generally associated with highly demanding and rigorous requirements due to the operational environment. The failure of an aircraft avionics component may place lives at immediate risk.

Avionics can be structured into navigation, communications, sensors and displays & data recording.

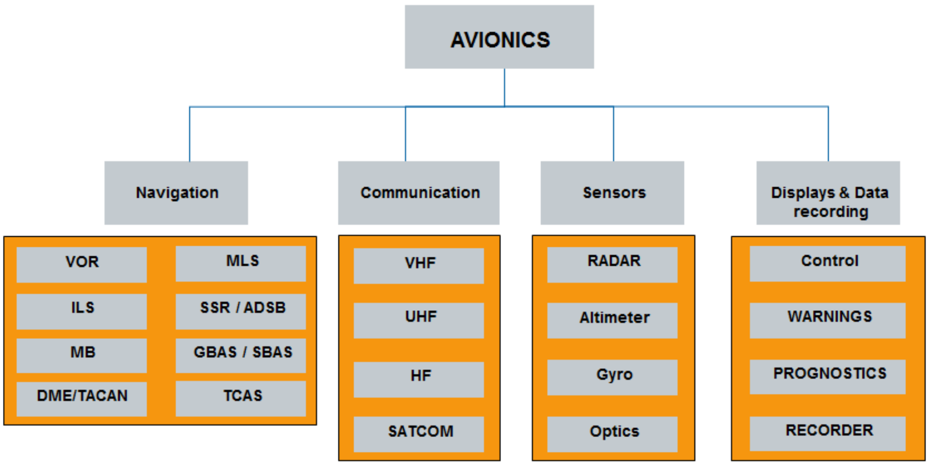


Fig. 1: AVIONICS overview.

1.1 Overview

DME is a radar system used to determine the slant distance of an aircraft to a ground station (DME transponder). For this purpose, shaped RF double pulses are transmitted by the aircraft to the ground station. After a defined delay (main delay), the ground station sends the pulses back again. The receiver in the aircraft uses the round trip time of the double pulses to determine the distance to the ground station.

The method is defined in International Civil Aviation Organization (ICAO) Annex 10 to the Convention on International Civil Aviation [1] and also in European Organization for Civil Aviation Electronics (EUROCAE) ED-57 [2].

1.2 Distance Measuring Equipment

1.2.1 Principles of Operation

Most DME ground stations are combined with a VOR system in order to allow an aircraft to determine its precise position relative to this station. The DME channels are paired with the VOR channels and range from 1025 MHz to 1150 MHz for the aircraft transmitter and 962 MHz to 1213 MHz for the ground stations. The frequency delta between the received and transmitted signal is always 63 MHz. The channel spacing between the various DME channels is always 1 MHz.

Each channel has two different codings (X and Y) that differ with regard to their pulse spacing. The assignment of a channel and coding to a ground station always remains the same during operation and is determined by the respective national ATC authority.

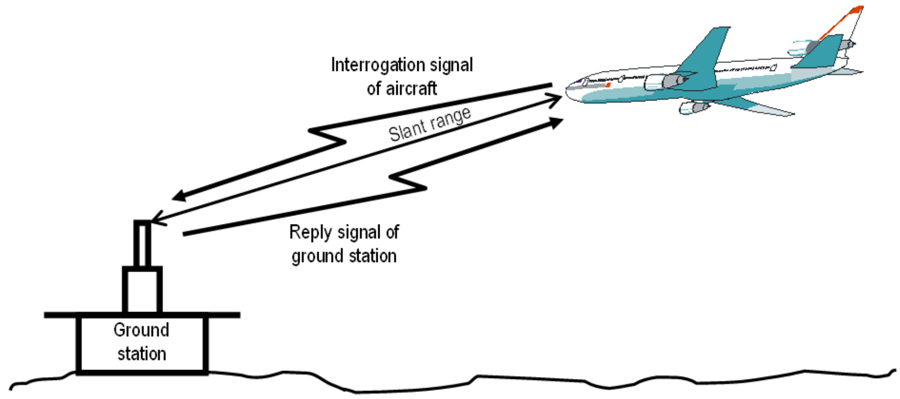


Fig. 2: DME principle.

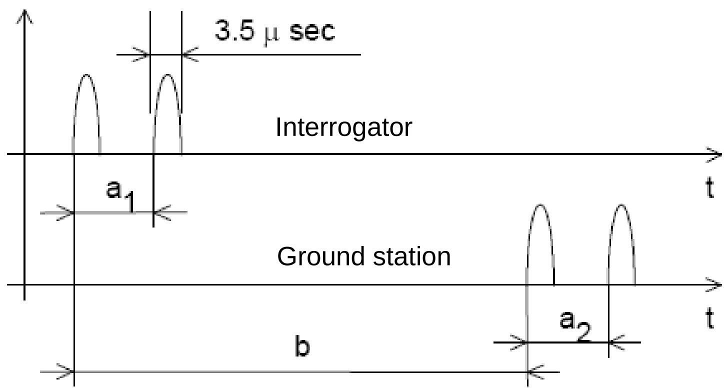


Fig. 3: DME timing.

x – Mode:
- Coding: a1 = a2 = 12 µs
- Main delay (b) = 50 µs

y – Mode:
- Coding: a1 = 36 µs; a2 = 30 µs
- Main delay (b) = 56 µs

In order to limit the bandwidth of the DME signal to the channel width of 1 MHz, the envelope of the pulses is shaped taking the specified rise and fall times into consideration.

There are two different DME standards (DME/N and DME/P) that mainly differ with respect to the rise time of the pulse edge. Since DME/N is the standard that is generally used at present, only DME/N will be considered below.

DME/N pulse parameters:

Pulse width (50% amplitude)	3.5 µs ± 0.5 µs
Rise time (10% _ 90% of amplitude)	0.8 µs to 3 µs
Fall time (90% _ 10% of amplitude)	< 3.5 µs
ON/OFF ratio	80 dB

The overall accuracy of the DME/N system is approx. ±0.1 NM (±185 m)
(1 NM = 1 nautical mile = 1852.02 m).

1.2.2 Interrogator

The aircraft's interrogator sends random distributed pulses to the ground station. These pulses are received and returned to the interrogator after the main delay at the transponder frequency (frequency offset of 63 MHz to the interrogation frequency). The receiver in the aircraft determines the time difference between the transmitted and received pulse. It then uses this time to calculate the slant range to the ground station. The distance is usually indicated in nautical miles (NM). As a result, by taking the flight altitude above ground as well as the azimuth angle between the aircraft and ground station (VOR/DME system) into consideration, it is possible to determine the precise position of the aircraft.

The interrogator can be in three different modes (states):

- SEARCH mode
- TRACK mode
- MEMORY mode

In SEARCH mode, the interrogator attempts to set up a connection to a ground station and to synchronize to this ground station. In this mode, the pulse repetition rate can be increased up to 150 pp/s (pp/s = pulse pairs per second).

DME and TACAN ground stations always send out a certain number of pulses per second (squitter pulses and replies to requests of planes). Since all these pulses are randomized, the interrogator uses correlation methods to find the replies to its own interrogations. The following graph explains how this works.

It shows all DME pulses the interrogator receives from a DME ground station in a time interval of 4 ms after a request pulse of the interrogator. As explained above these are squitter pulses *and* replies to different interrogation requests (e.g. different planes). The interrogation time is set to t_0 = 0 ms and all received double pulses are displayed as small triangles for the sake of simplicity. On the y-axes the diagram shows the results for six consecutive requests of the interrogator. The interrogator can then easily filter out the replies to its own interrogations (marked in red - always at the same time in all six diagrams).

Remark: The maximum time in which the receiver of the airborne interrogator can expect a reply to its request is set to 4 ms (corresponds to ~320 NM distance to the DME or TACAN ground station). Stations with longer distances are ignored.

After the interrogator has synchronized to the ground station, it changes to TRACK mode and performs the distance measurement with a maximum of 30 requests per second in a significantly reduced time window around the expected arrival time of the reply pulses.

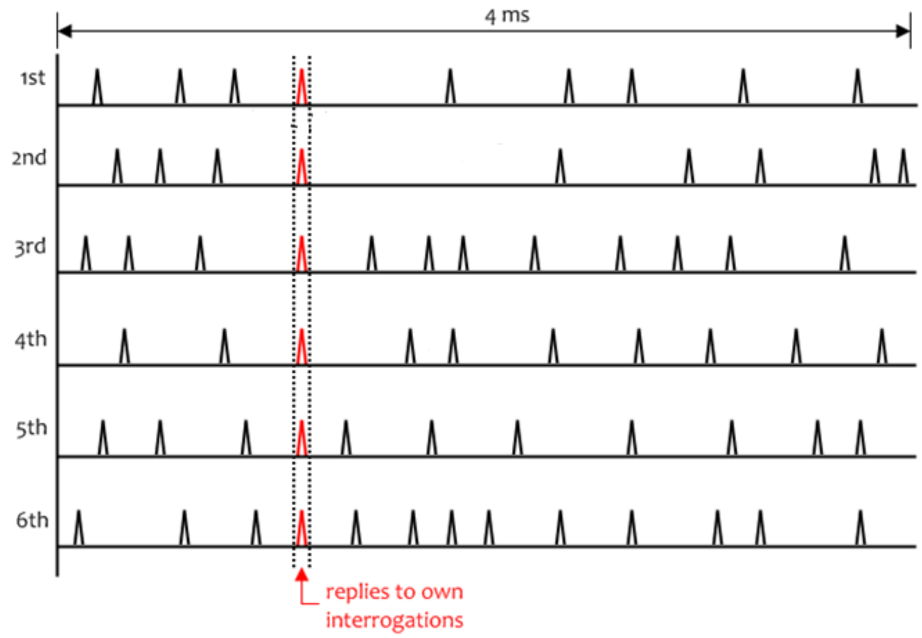


Fig. 4: Filtering the received pulses in search mode.

If the interrogator loses the track (e.g. due to very low signal levels or strong multipath scenarios), it usually does not return to SEARCH mode immediately but goes to MEMORY mode. In this mode the interrogator tries to retrieve synchronization without performing a new SEARCH operation (the expected time window for the replies is unchanged). If synchronization is regained within the MEMORY time (usually 10 s), the interrogator changes back to TRACK mode. If this is not the case, the interrogator switches back to SEARCH mode.

The transmit power of an aircraft interrogator is typically between 250 W and 500 W.

1.2.3 DME Ground Station

DME ground stations can be divided into three different types:

- DME enroute stations with 1 kW peak power are used for route navigation over large distances with a maximum range of approx. 200 NM (approx. 370 km)
- TACAN ground stations are also used by civil aircraft and can have output peak power of 3 kW
- DME terminal stations with 100 W pulse power are used for landing approach and therefore over short distances of up to 60 NM (approx. 110 km)

The coverage of the DME stations is attained by using stacked antennas with an antenna gain of e.g. 10 dBi (depending on the number of used elements). Additionally, DME antennas have an elevation of 4 to 6° (reduction on multipath).

In the receiver part of the ground station, the validity of all received pulses (i.e. the pulse spacing must be consistent with the channel) is checked in the "decoder". A single pulse, for example, is filtered out as an invalid interrogation and no reply to this pulse is sent. After a valid DME double pulse is received (i.e. after the second pulse is received), the receiver at first does not react to any further interrogations for the so called **dead time** (about 60 µs long) to ensure that the transponder will not react on invalid interrogations created by multipath scenarios (echoes). In this time period, the receiver is therefore not ready to process new interrogation pulses. All pulse interrogations that are received at the DME ground station during the dead time are not answered.

A reply pulse is sent with a defined delay (= main delay or reply delay) after a valid interrogation pulse has been received. The **main delay** of a DME ground station is an important parameter determining the accuracy of the distance measurement. For this reason, the main delay is continuously checked by internal means (monitor with alarm functionality) and must also be measured externally in defined service intervals. Moreover, it is necessary to regularly check whether the alarm function of the monitoring system is working correctly.

For identification purposes, a DME ground station transmits an **ID code** (e.g. MUC for Munich) every 30 seconds (33 seconds for TACAN ground stations) instead of replies or squitters. The letters are sent in Morse code with a dot length of approx. 100 ms and a dash length of approx. 300 ms. The gap between two Morse characters is typically 100 ms and the gap between two Morse letters is 300 ms.

During the dot and dash times, the DME stations sends double pulses with a pulse repetition rate of 1350 pp/s (fixed). During these times, a station does not react to any interrogation pulses, which is why these times are also referred to as "**key down times**". Reply or squitter pulses are sent as usual between the key down times. The maximum length of an ID sequence is 10 s and the key down time must not exceed 5s.

The **reply efficiency** of a DME system is the ratio of the number of sent pulses to the number of received interrogation pulses from aircraft. A reply efficiency of 100 % is very rarely achieved since, as described below, there are several reasons why no reply pulse is sent on an interrogation pulse request:

- Interrogation pulse during the **dead time** of the receiver
- Interrogation pulse occurs in the key down time of an **ID sequence** (or during an MRB/ARB sequence of a TACAN ground station)
- Level of the interrogation pulse below the **receiver sensitivity** of the ground station. The reply efficiency drops dramatically when the maximum distance to the ground station is reached

The reply efficiency is also often used as a limit for certain receiver tests. The typical input level range for a DME station is between –95 dBm and 0 dBm. It is specified that the DME station must reply to at least 70% of the requests if the input level is above the lower limit (–95 dBm).
To test the receiver sensitivity of a ground station the input level is decreased until the reply efficiency drops to 70 %.

If the average transmit pulse rate at a DME ground station drops to values below 700 pp/s e.g. due to a low number of requests by aircraft, the ground station adds random **squitter pulses** to ensure that a minimum pulse rate is provided. This minimum pulse rate is necessary in order to facilitate synchronization of the automatic gain control of an aircraft receiver to the signal of a ground station.

The most important pulse parameters of a ground station

- Rise time
- Fall (or decay) time

- Pulse width
- Pulse spacing
- Pulse delay and
- Pulse peak power

are continuously monitored and adjusted by built-in test equipment (BITE) while the system is in operation. However, as the main delay these parameters must be verified externally during regular servicing of the DME station.

1.2.4 TACAN Ground Station

Tactical Air Navigation (TACAN) is the military version of DME. In addition to distance measurement (which works identically to a DME station), it also enables an aircraft to determine the azimuth between the aircraft and ground station. Civil aircraft can use the DME part (distance information) of a TACAN station whereas military aircraft also can evaluate the azimuth.

All pulses of a TACAN system are transmitted by a rotating antenna with a special radiation pattern, generating two-tone (15 Hz and 135 Hz) amplitude modulation to the envelope of the DME pulses received from a TACAN aircraft interrogator.

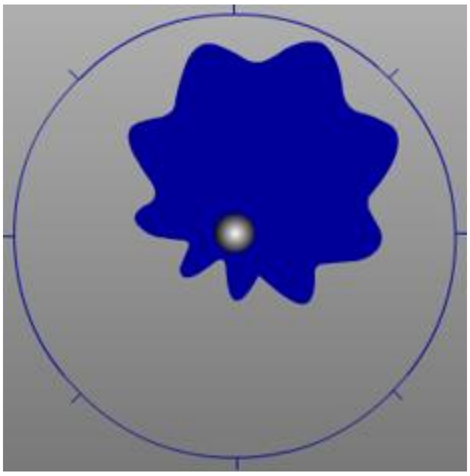


Fig. 5: TACAN antenna diagram.

To allow a TACAN receiver on-board an aircraft to determine the direction, a TACAN ground station sends specially coded pulse pairs in addition to the DME pulses. This involves one main reference burst per 15 Hz period (MRB) and one auxiliary reference burst per 135 Hz period (ARBs).

The TACAN receiver determines the azimuthal direction by evaluating the phase relation between the 15 Hz amplitude modulation and the MRB. The phase relation between the 135 Hz signal and the ARBs is used to increase the azimuth accuracy. Accordingly, the accuracy of the azimuth determination of a TACAN ground station is higher than that of the VOR method used in civil aviation.

Since the amplitude modulation is generated by a rotating antenna, the pulse peak amplitude at the transponder output (or antenna input) is, like for a DME transponder, constant.

TACAN ground stations work with a higher number of pulses per second (normal squitter rate = 2700 pp/s) to ensure that the two tones have a sufficient number of sampling points even if the request rate is low.

2 Field Measurements with the R&S®EDS300

Manual Testing of Radio Navigation Aids, Volume 1, ICAO DOC 8071 [3] specifies all parameters of a DME/TACAN station that have to be checked regularly via ground or flight inspection (in addition to internal built-in test and field monitors).

Many tests on DMEs and TACANs are performed today at the AF outputs of the stations (oscilloscope). The R&S®EDS300 allows execution of these tests on DME and TACAN stations directly on the RF signal (e.g. on a directional coupler). Additionally, the R&S®EDS300 is able to perform field measurements via an antenna and analyze all important parameters.

The following sections focus on the field measurement capability of the R&S®EDS300. The following DME parameters can be measured:

- Distance / time delay
- Reply efficiency
- Peak power
- Pulse repetition rate
- Pulse shape (rise/decay time, pulse spacing/width and amplitude difference)
- Identifier code and repetition rate

On TACAN ground stations the following parameters can be measured additionally:

- Bearing
- MRB/ARB pulse counts/spacing
- MRB/ARB repetition rate
- 15/135 Hz modulation depth and AF frequency
- 15/135 Hz phase and phase shift

2.1 Measuring a DME in the Field

2.1.1 Test Setup

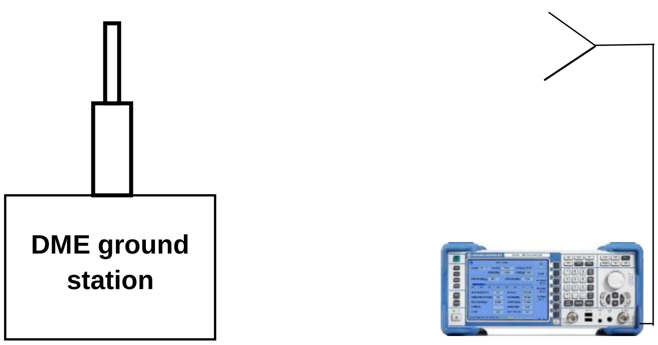


Fig. 6: Test setup for DME measurements in the field.

To perform DME tests in the field the R&S®EDS300 should be placed at a known distance within line of sight of the DME ground station. The internal interrogator of the R&S®EDS300 works on RF IN/OUT 1 – so the antenna must be connected to RF IN/OUT 1. Use the SETUP to configure the internal interrogator (e.g. min. reply efficiency for TRACK).

To keep the influence of multipath signals low, it is recommended to use a directional antenna with low side lobes and a high front to back ratio (e.g. a corner reflector antenna).

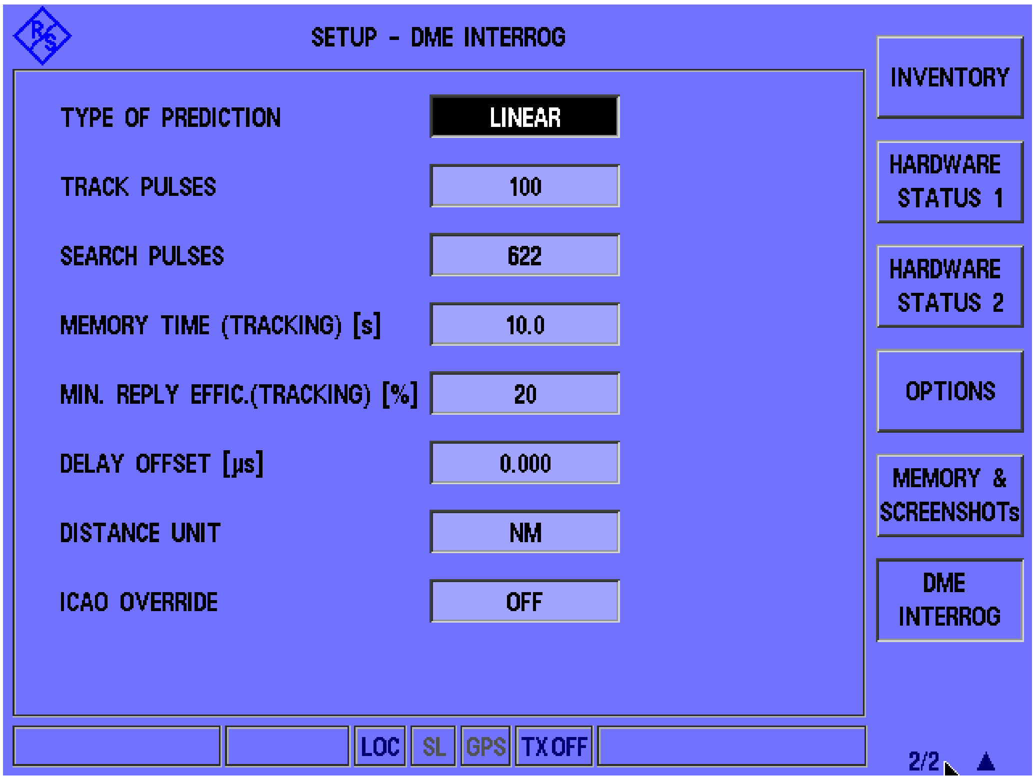


Fig. 7: Setup for the R&S®EDS300.

The 20 W peak power of the low-power interrogator (R&S®EDS-B2 option) is sufficient for most measurements on the ground (e.g. on a DME terminal station of an airport). Only for large distances can it be necessary to use the high-power interrogator (R&S®EDS-B4 option).

2.1.2 Measurement of DME Parameters

Select the correct DME channel by using the CHAN hard key (e.g. 24X). The R&S®EDS300 receives the DME pulses from the ground station and directly indicates the peak and average power, the frequency offset, the pulse repetition rate and the pulse spacing.

Switch on the interrogator by toggling the TX soft key.

Note: Regardless of the menu or screen you enter, the R&S®EDS300 indicates in the status line whether TX is switched on or off (TXON / TXOFF).

When TX is switched on the R&S®EDS300 first enters the SEARCH mode with the PRR SEARCH and searches for the correct reply pulses of the DME station to the interrogations. After successful detection it enters the TRACK mode and reduces the number of request pulses to the PRR TRACK.

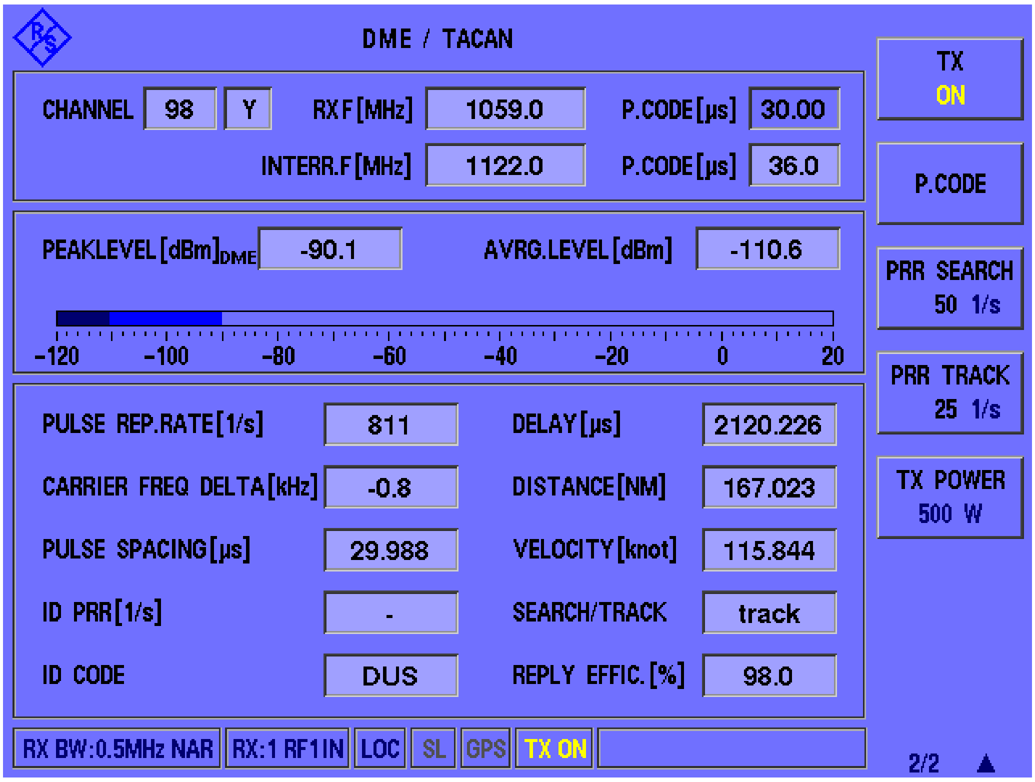


Fig. 8: Measurement results on a DME station (channel 98Y).

With TX switched on the R&S®EDS300 measures the time delay between the interrogator pulses and the reply pulses taking into account the main delay of the station (see Fig. 8). The R&S®EDS300 computes the distance (slant range) to the ground station based on the following equation:

$$r = \frac{C}{2} * (\Delta t - \tau_0)$$

Where

r = Slant range

C = Speed of light

Δt = Measured time delay

τ_0 = Main delay (50 µs for X-channels, 56 µs for Y-channels)

From the number of received replies to its own interrogations, the R&S®EDS300 computes the reply efficiency and decodes the station identifier. Note that during the ID the ground station does not respond to interrogations (see section 1.2.3).

The pulse code of the interrogator of the R&S®EDS300 can be varied from 11 µs to 42 µs. This allows checking of the decoder functionality of a DME station as described by DOC 8071. The reply efficiency of the DME ground station must not change if the pulse code varies within ±0.4 µs and it should not reply if the pulse spacing deviates more than 2 µs from the nominal value.

2.1.3 Evaluation of the Pulse Shape

The R&S®EDS300 always checks whether the received pulses have the correct pulse shape (rise time, fall time, pulse width) and the correct coding / pulse spacing (see section 1.2.1). If the pulses are correct DME pulses with the correct coding, it displays the symbol “DME” besides the level indication:

Fig. 9: Measurement of the DME peak power.

The measured value for the pulse spacing is always displayed on the DME screen.

Furthermore, the Pulse View provided by the R&S®EDS300 (R&S®EDS-K2) allows deeper analysis of the received pulses in the time domain.

Enter the Pulse View by pressing the “Pulse View” hard key. Set TIME/DIV (e.g. to 5 µs), select the unit (UNIT to V, W or dBm) and set the y-scale dependent on the level of the received pulses.

The easiest way to obtain a stable display is to trigger on the DME double pulses and define a trigger level. In this case the R&S®EDS300 shows all double pulses (squitter pulses, replies to other requests e.g. interrogators on-board planes in range and reply pulses).

If you use the Pulse View during TXON in TRACK mode, it is also possible to trigger on the interrogator pulses of the R&S®EDS300. This additionally allows measurement of the main delay of a DME or TACAN station in the Pulse View.

Use the MARKER hard key to activate the marker menu. The measurements of

- Rise time
- Decay time
- Pulse spacing
- Pulse duration and
- Peak variation

can be performed manually by using the marker functions or automatically by selecting the "ANALYSIS – All params" soft key.

Multipath propagation occurs due to reflections of the DME signal (e.g. on mountains, buildings and the earth's surface). With the Pulse View the reflected signal components can be measured.

Fig. 10 shows a DME signal and a reflected signal component (first reflected signal, ~180° out of phase) with an attenuation of ~13.2 dB and a delay of 4.8 µs (Marker 1 – Marker 2)

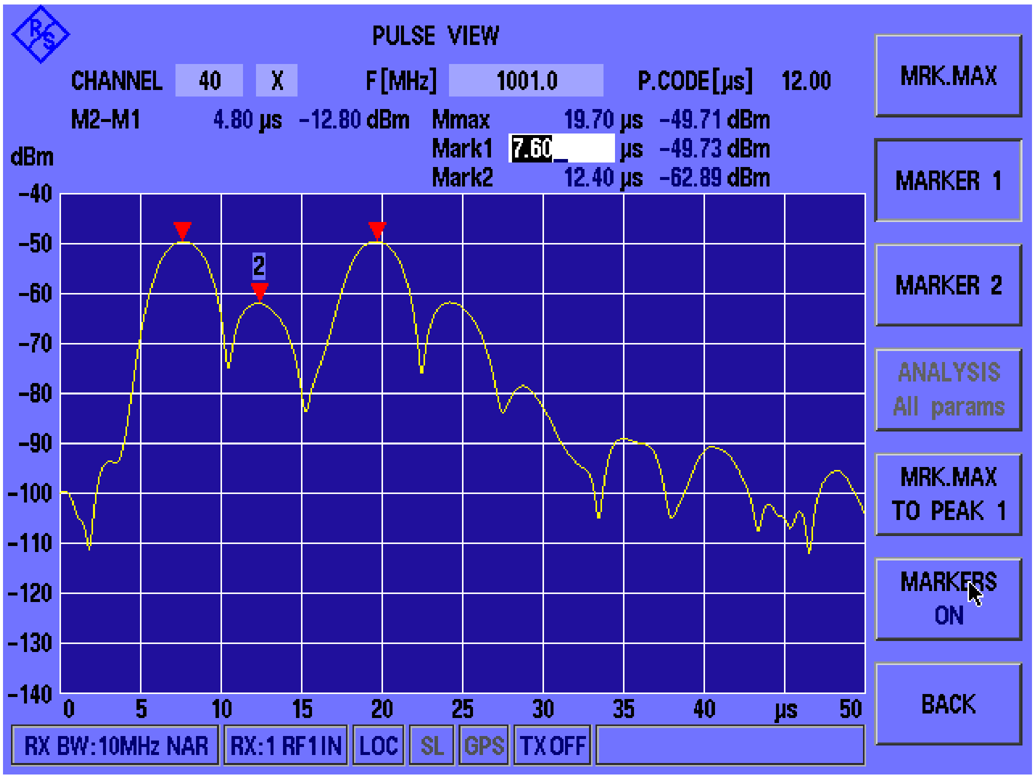


Fig. 10: Analysis of a DME's pulse shape (reflected signal with 4.8 µs delay).

2.1.4 Monitoring with R&S®EDS-K5

In addition to the monitors of the actual DME stations, remote monitoring of all DME stations in "sight" gives an ideal overview of the availability and quality of the DME signal in the monitored area. For this purpose, the R&S®EDS300 has a multi-DME mode (R&S®EDS-K5) that allows measurement of up to ten different DMEs in sequence.

One major pre-condition is to find a suitable spot where to put the R&S®EDS300 and the antenna. Normally from mountain tops or airport towers there is good line of sight probability to a few DMEs (or also TACANs) which leads to satisfactory and stable results.

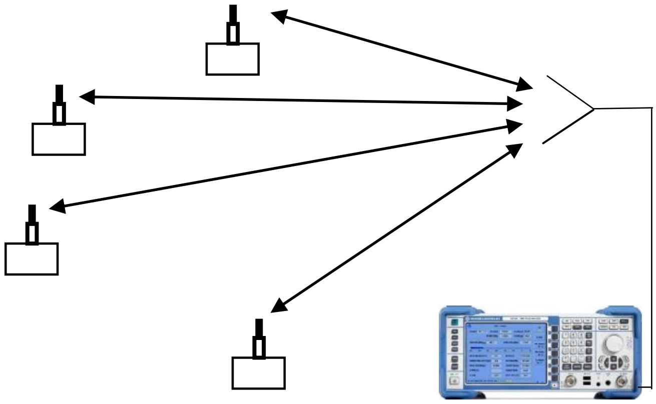


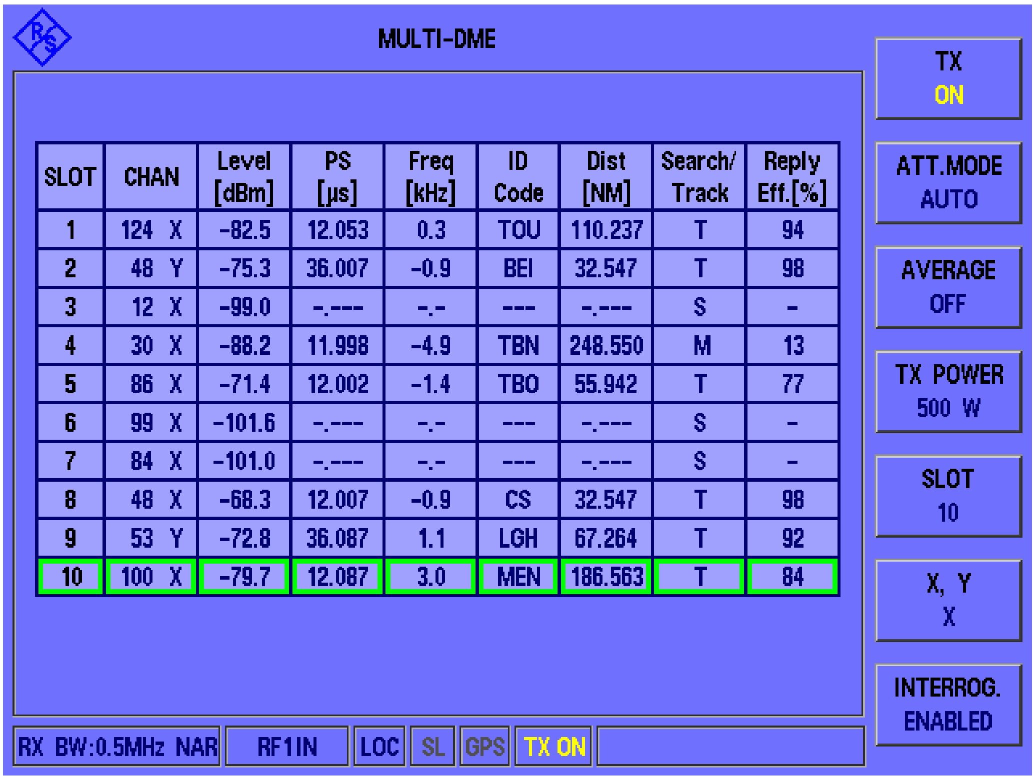
Fig. 11: Test setup for monitoring up to ten DME stations in the field.

The selection of an appropriate antenna is essential and depends very much on the site. For most sites, a directional antenna should be used to keep the influence of multipath signals low.

Enter the multi-DME mode of the R&S®EDS300 by pressing the SEQ hard key. Select slot 1 and press the CHN soft key to select the DME channel to be monitored on slot 1. Make sure that TX is enabled for this slot if you want this DME to be interrogated. Do the same for all DMEs that you want to monitor and put in the necessary peak power for the TX (dependent on the distance to your DME stations).

Switch on the interrogator (TX ON). The R&S®EDS300 indicates for each slot whether it is in SEARCH, TRACK or MEMORY mode and shows the following measured values:

- Peak power
- Pulse spacing (coding)
- Frequency offset
- Identifier
- Distance
- Reply efficiency



SLOT	CHAN	Level [dBm]	PS [µs]	Freq [kHz]	ID Code	Dist [NM]	Search/ Track	Reply Eff.[%]
1	124 X	-82.5	12.053	0.3	TOU	110.237	T	94
2	48 Y	-75.3	36.007	-0.9	BEI	32.547	T	98
3	12 X	-99.0	-.---	-.-	---	-.---	S	-
4	30 X	-88.2	11.998	-4.9	TBN	248.550	M	13
5	86 X	-71.4	12.002	-1.4	TBO	55.942	T	77
6	99 X	-101.6	-.---	-.-	---	-.---	S	-
7	84 X	-101.0	-.---	-.-	---	-.---	S	-
8	48 X	-68.3	12.007	-0.9	CS	32.547	T	98
9	53 Y	-72.8	36.087	1.1	LGH	67.264	T	92
10	100 X	-79.7	12.087	3.0	MEN	186.563	T	84

Fig. 12: MDME screen of the R&S®EDS300.

2.2 Measuring a TACAN in the Field

2.2.1 Test Setup

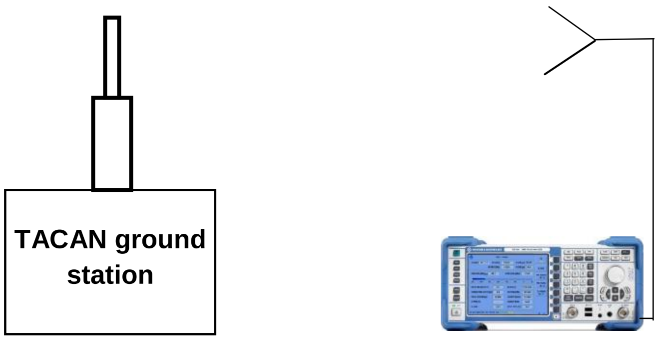


Fig. 13: Test setup for TACAN measurements.

The test setup is very similar to the DME test setup but for TACAN tests in the field the R&S®EDS300 should be placed at a *known position* (known distance and known angle) with line of sight to the TACAN station.

2.2.2 Measurements with R&S®EDS-K1

The DME part of the measurements is identical to section 2.1. Toggle the VIEW DME soft key to VIEW TACAN 1. The R&S®EDS300 shows the bearing, the modulation depth and frequency of the AF signals, the phase shift between the two AF tones, the absolute phase of the 15 Hz signal to the main reference burst (MRB) and the absolute phase of the 135 Hz signal to the auxiliary reference burst (ARB).

VIEW TACAN 2 shows additional TACAN values such as the MRB/ARB pulse count, pulse spacing and repetition rate.

For TACAN stations, it is important to measure the performance of the TACAN station for angles of 0° to 360°. Since this type of measurement cannot normally be performed from the ground, flight inspection systems are used so it can be performed on-board a flight inspection plane (see section 2.3.3).

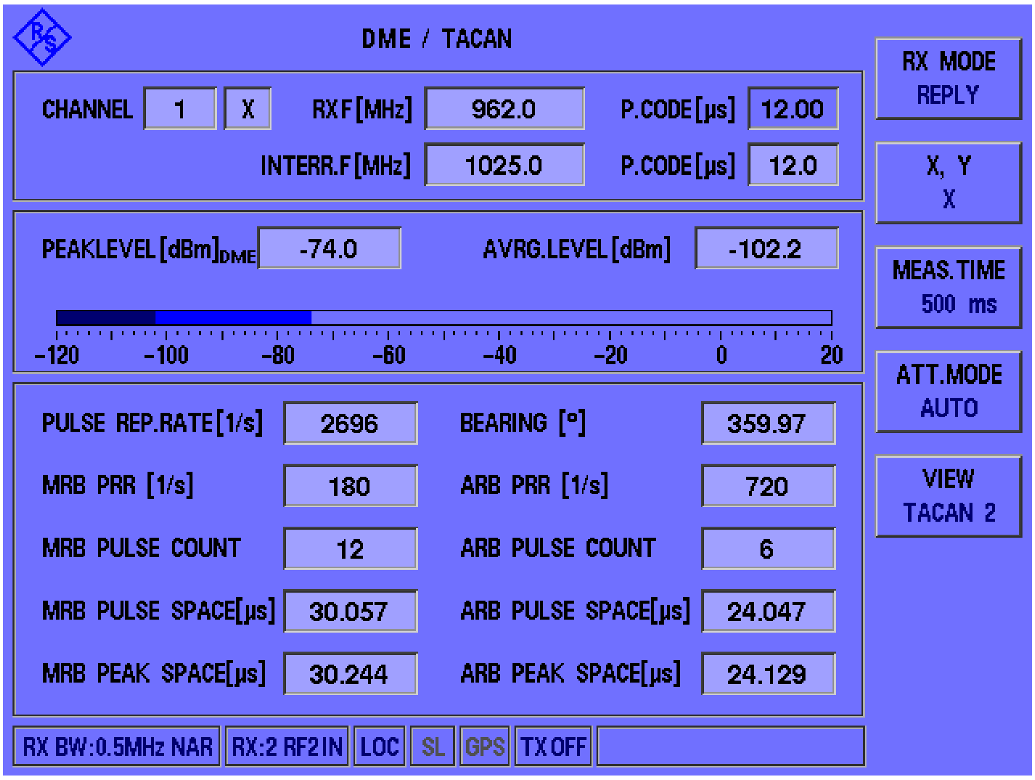


Fig. 14: TACAN screen of the R&S®EDS300.

2.3 Flight Inspection of DMEs and TACANs

Flight inspection of terrestrial navigation systems is mandatory according to the ICAO norms. All necessary measurement and test equipment is installed in a dedicated measurement plane.

2.3.1 Flight Inspection System (FIS)

Flight inspection systems are measuring systems that are installed in flight inspection planes. These systems normally consist of

- Special antennas for mounting on flight inspection planes and for the different frequency ranges and measurement tasks (ILS, VOR, DME, etc.)
- Switch units for connection of the dedicated antenna to the selected analyzer
- Various analyzers
- Flight inspection computer and software

Since the R&S®EDS300 is specified for operation up to 4600 m, it can be used for all common flight inspection scenarios (approaches, orbits, etc.). Due to its small size, DC power input and LAN interface, the R&S®EDS300 allows easy mechanical and electrical integration into a flight inspection system.

The recommended hardware configuration of the R&S®EDS300 is:

- R&S®EDS-B1 and
- R&S®EDS-B4 (high-power interrogator)

Connect RF IN/OUT 1 of the R&S®EDS300 to the dedicated DME antenna for flight inspection (usually different from the primary DME antenna for navigation). The total attenuation of the wiring (from antenna to the R&S®EDS300) can be corrected in the SETUP.

Connect the suppressor input/output on the rear of the R&S®EDS300 to the suppressor line of the FIS to protect other receivers when the internal interrogator of the R&S®EDS300 is transmitting and vice versa to protect the RX input of the R&S®EDS300 when other transmitters on board are temporarily active.

2.3.2 MDME

One of the key objectives during regular flight inspection of DME stations is to measure as many DMEs in parallel as possible. The multi-DME mode (R&S®EDS-K5) of the R&S®EDS300 allows measurement of up to ten different DMEs in a sequence of 50 ms.

Normally the measurements made with on-board flight inspection systems are automated and the flight inspection software will acquire all of the measured values via remote control of the R&S®EDS300.

See section 2.1.4 for information on manual operation of the MDME mode (e.g. for tests). The screen of the R&S®EDS300 will show the results for ten DME slots in a list (see Fig. 12). All measurements can be stored on an external USB stick (USB data logger) or can be automated via LAN.

The FI software normally uses the stream mode of the R&S®EDS300 to acquire and display the measurement results for a test flight (see example in Fig. 15).

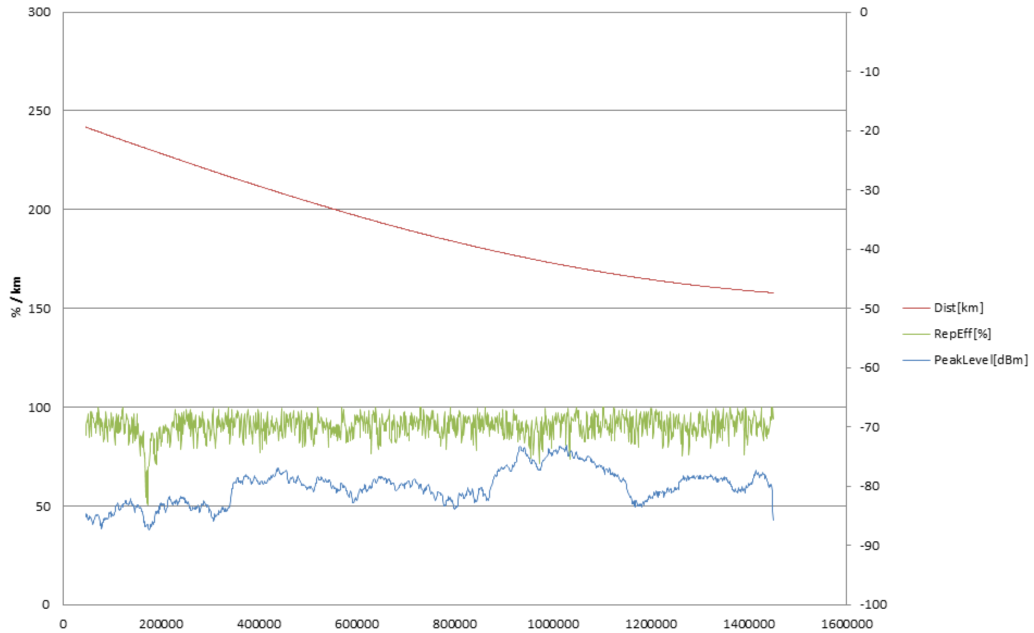


Fig. 15: Results from an MDME flight inspection for one of the DME stations.

2.3.3 TACAN

When integrated into an FIS, the R&S®EDS300 can stream out all TACAN parameters (see section 2.2.2). Orbital measurements can be performed around a TACAN ground station to identify the behavior of the TACAN station from every angle. Fig. 15 shows the modulation depth and the TACAN error for an orbit flight of 360°.

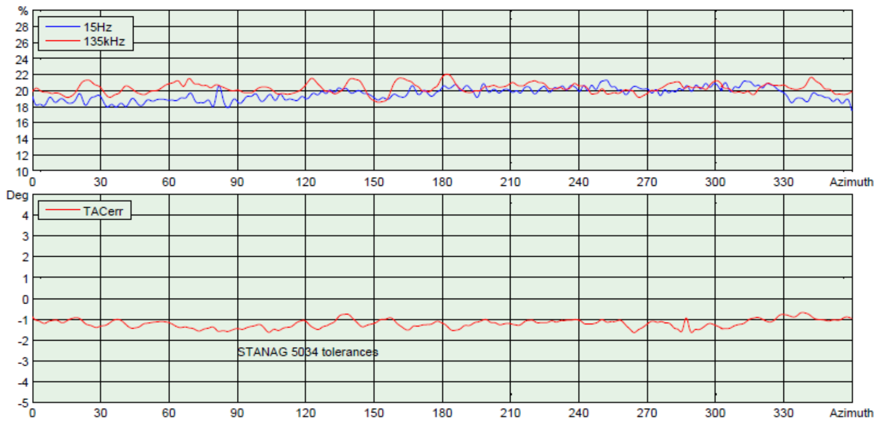


Fig. 16: Results from a TACAN flight inspection.

3 Conclusion

This Application Note introduced a variety of field measurements for DME and TACAN ground stations. The flexibility of the R&S®EDS300 allows measurements to be performed from the ground and/or the flight inspection aircraft.

The R&S®EDS300 acts and behaves like the on-board interrogator of a normal plane but additionally it is able to perform very fast and precise measurements of all DME and TACAN parameters. Its high sensitivity make it ideal for performing field measurements from the ground or on-board flight inspection planes.

4 Literature

[1] Annex 10 to the Convention on International Civil Aviation, Volume 1 (Radio Navigation Aids), Sixth Edition of Volume 1 – July 2006; International Civil Aviation Organization Annex 10, Volume I Radio Navigation Aids, ICAO

[2] Minimum Operational Performance Specification for Distance Measuring Equipment (DME/N and DME/P) (Ground Equipment), EUROCAE (European Organization For Civil Aviation Electronics) ED-57, Edition 2, October 1992

[3] DOC 8071 Manual on Testing of Radio Navigation Aids, Volume 1 Testing of Ground Based Navigation Systems, Fourth Edition – 2000; International Civil Aviation Organization

[4] R&S®EDS300 DME/Pulse analyzer data sheet and operating manual:
www.rohde-schwarz.com/product/EDS300

[5] Application Note 1GP74: Test of DME/TACAN Transponders
http://www.rohde-schwarz.com/en/applications/test-of-dme-tacan-transponders-application-note_56280-15662.html

5 Ordering Information

Designation	Type	Order No.
Base unit		
DME/Pulse Analyzer	R&S®EDS300	5202.7006.02
Hardware options		
Additional RX Unit	R&S®EDS-B1	5202.7170.02
Low-Power Interrogator	R&S®EDS-B2	5202.8160.02
High-Power Interrogator	R&S®EDS-B4	5202.8177.02
High-Power Amplifier	R&S®EDS-B5	5202.7193.02
Software options		
TACAN Analysis	R&S®EDS-K1	5202.8102.02
Pulse Shape Analysis	R&S®EDS-K2	5202.8119.02
GPS Synchronization	R&S®EDS-K3	5202.8125.02
Multi-DME Mode	R&S®EDS-K5	5202.8131.02

6 Glossary

ADSB:	Automatic dependent surveillance – broadcast System to periodically broadcast the aircraft position
ARB:	Auxiliary reference burst Burst of a TACAN signal to determine the phase of the 135 Hz AM signal
BITE:	Built-in test equipment
DME:	Distance measurement equipment Distance measurement method in aviation
DME/N:	DME narrow spectrum characteristic Standard DME method that is used almost exclusively in civil aviation for distance measurement
DME/P:	DME precise More precise DME method that is seldom used at present
DOC 8071:	ICAO test specification for testing navigation aids
EUROCAE:	European Organization for Civil Aviation Equipment European authority that defines civil navigation standards
FIS:	Flight inspection system System used on-board aircraft to perform measurements in NavAid signals
GBAS:	Ground based augmentation system Landing system based on differential correction of the GPS signal
GNSS:	Global navigation satellite system Satellite system with global coverage
GPS:	Global positioning system
ICAO:	International Civil Aviation Organization International authority that defines civil navigation standards
ID Code:	Identification code
ILS:	Instrument landing system Navigation aid used during aircraft landing approach
MLS:	Microwave landing system
MB:	Marker beacon Navigation aid used during aircraft landing approach
MRB:	Main reference burst Burst of a TACAN signal to determine the phase of the 15 Hz AM signal
NM:	Nautical mile; 1 NM = 1805.02 m
pp/s:	Pulse pairs per second
PRR:	Pulse repetition rate Number of pulses per second
SBAS:	Satellite based augmentation system System that supports augmentation through additional satellite-broadcast messages
SSR:	Second surveillance radar Active radar system (interrogator, transponder)
TACAN:	Tactical air navigation Military DME variant that also enables azimuthal direction determination.
TCAS:	Traffic alert and collision avoidance system System that warns pilots of the presence of other transponder-equipped aircraft to avoid collisions
VOR:	VHF omnidirectional radio range Navigation aid for azimuthal direction determination

About Rohde & Schwarz

The Rohde & Schwarz electronics group is a leading supplier of solutions in the fields of test and measurement, broadcasting, secure communications, and radiomonitoring and radiolocation. Founded more than 80 years ago, this independent global company has an extensive sales network and is present in more than 70 countries. The company is headquartered in Munich, Germany.

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