

TECHNICAL SPECIFICATIONS ON NAVAIDS DME (Distance Measuring Equipment)

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DME (Distance Measuring Equipment)

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1 Scope

DME according ICAO Annex 10

This Specification covers all items required to implement an DME in terms of the relevant ICAO- Specifications, listed as item 2:

Basic Versions

The DME equipment shall be available in a lower power and the higher power versions of a complete family of latest-generation equipment composed by:

- **Approach DME:** a 100 W solid-state DME to be installed in co-location with ILS.
- **En-route DME:** a 1 kW solid-state DME to be installed in co-location with VOR or DVOR.

Auxiliary Services,

such as:

- Mains- and Battery Power Supply
- Signalling line interfaces
- Shelters
- Frame work, masts and poles
- RF- cabling

are specified in brief terms.

References

The Tenderer is requested to make proof in his proposal to manufacture at least DME, ILS, VOR and DVOR equipment in his own premises and shall include references on worldwide installations performed.

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2 Standards

The following Standards shall be applicable in their latest edition, including the latest amendments and additions, in all respects:

2.1 Standards of General Application

- International Civil Aviation Organisation (ICAO) - Annexes, Documents and Manuals
- Eurocae MPS Ed. 57, standard 1 as applicable;
- Comité Consultatif International Télégraphique et Téléphonique (CCITT)
- Comité Consultatif International Radio (CCIR)
- International Standardisation Organisation (ISO)
- International Electrotechnical Commission (IEC)
- International Colour Coding (ICC)
- Euro- Norm (EN) or equivalent
- Deutsche Industrie- Norm (DIN) or equivalent
- Verband Deutscher Elektroingenieure (VDE) or equivalent

2.2 Standards of Special Application

Note: The Standards mentioned hereafter shall be met for the DME Equipment Performance Requirements

ICAO- Annex 10, Volume 1, Part 1:

Chapter 3, Section 3.5: *Specification for DME*
 Attachment C to Part 1, Section 1 and 2- *Material concerning DME installations*
 Attachment C to Part 1, Section 8- *Material concerning power supply switch over times*
 Attachment F to Part 1: *Guidance material concerning reliability and availability of radio communications and navigation aids*

ICAO- Annex 10, Volume 1, Part 2:

Chapter 4, Section 4.2.- *(Frequency-) Utilisation in the band 108- 117,995MHz*

ICAO- Annex 14, Volume 1:

Chapter 4, Section 4. 1: *Obstacle limitation surfaces*

ICAO- DOC 8071, Volume 11:

Manual on Testing of Radio Navigation Aids, ILS

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3 Equipment Requirement

The equipment proposed by the Tenderer shall comply with the Requirement listed below.

The DME shall consist of a 100W or 1 kW ground beacon housed in a 19' cabinet with two transponders and a dual microprocessor-controlled monitoring system with built-in test equipment.

The DME shall be compatible with DME/P airborne interrogators for IAM only. It shall operate as a **STAND ALONE** unit, but shall be conceived to be **COLOCATED** with other navaids equipment such as VOR and DVOR.

3.1 General Requirement

3.1.1 *Electrical*

3.1.1.1 *Input Voltage*

The AC- input voltage shall be:

230 Volts or 115 Volts nominal

Tolerance: +15%, -15%

Frequency: 48 to 64 Hz

3.1.1.2 *Battery Protection*

Automatic protection against battery overcharging shall be incorporated in the power supply by means of a constant voltage circuit.

3.1.1.3 *Stray Radiation*

The power supply/charger unit shall not emit any stray radiation causing interference to radio environment. The radio interference classification shall be listed in the Tenderer's proposal.

3.1.1.4 *DC Supply Voltage*

The D.C. output shall provide a nominal voltage below or equal 48 Volts at a current sufficient to operate the equipment and charge batteries at the same time. Interdependent voltage and current regulation shall be provided.

3.1.1.5 *Battery Charging Power Supply Configuration*

Independent power supply units shall share the charging of the common battery set and the equipment load from a common bus bar. The arrangement shall be a dual configuration; i.e. for a dual equipment configuration 2 power supply units shall share the load.

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In case of removal or failure of one unit the equipment supply shall not be interrupted, the remaining power supply unit shall still be capable to supply the dual equipment; the battery-charging period shall be increased, only. The charging time (from 10%-90% battery capacity) shall not exceed:

10 hours for full power supply configuration
36 hours for single power supply configuration

3.1.2 Mechanical

3.1.2.1 Configuration

The electronic equipment shall be mounted in a 19" cabinet installed in a shelter. The framework shall be of galvanised steel or anodised aluminium.

3.1.2.2 Modular Construction

For rapid replacement of units, the cabinet shall contain equipment carriers, in which individual plug in units and modules shall be inserted.

Drawers will not be accepted.

All the plug-in units and modules (including RF-modules) shall fit on slide rails and shall be removable from the front of the cabinet. Connectors shall be keyed to prevent insertion of units in the wrong way or into a wrong slot. Also the RF-Connectors of the modules shall be plug-in type.

3.1.2.3 Plug-In Units

3.1.2.3.1 Printed Circuit Boards

Printed circuit boards shall be used exclusively, also for inter wiring between circuits inside of plug-in units (printed mother boards). For reliability reasons printed motherboards shall also be used for cabinet and sub-assembly inter wiring.

3.1.2.3.2 Coatings

Printed circuits shall be coated by a photo solder resistant material in order to increase the electrical resistance of the surface, and decrease the surging effect caused by moisture and fungus on unprotected insulating surfaces.

The printed circuit board coating shall permit the replacement of components by soldering techniques without destroying the coating or the board surface.

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3.1.2.3.3 Controls

In order to avoid wear and tear, no mechanically operating control elements shall be accepted for direct signal adjustment. There shall be no potentiometers in the direct path of signal generation. **The number of potentiometers shall be limited to dc-alignments.**

In case of variable inputs, potentiometers shall be located on the front of the board, as to permit setting without removing the board or needing a card extender. Push buttons for input/output control and men/machine dialogue shall be sealed and protected against environmental effects.

3.1.2.3.4 Radio-Frequency Connections

RF cable connections within the electronic equipment shall be effected by means of coaxial connectors, throughout. RF cabling and interconnections between plug-in units and modules shall be located at the rear of the cabinet or sub rack by plug-in type connectors for the RF-modules. RF connections to the transmitting antenna system shall be accessible on RF output connectors located on a separate panel inside the cabinet.

3.1.2.4 Wiring

Inter wiring of units within subassemblies shall be made via motherboards (printed circuits).

3.1.2.5 Ventilation

Cooling inside the cabinet shall be effected by convection exclusively and shall assure all components to operate well within their individual temperature ratings within the specified equipment ambient temperature range. **Cooling by fans is not accepted.** Heat sinks for power components and power circuits shall be separated from low-power circuits to avoid unnecessary heat stress to low-power circuits.

3.1.2.6 Shelter

Equipment shelters shall be compact and completely fitted in a way, that plug-in units and modules need to be inserted and exterior cabling have to be connected to the respective distribution panels to assure a short installation time on site. Shelters shall be light-weight and shall be designed to serve as a self-supporting container for transportation. Shelter material shall be non-corrosive.

Wall and ceiling elements shall be sandwich panels made of 1,2 mm thick AlMgSi sheeting on the inner and outer side. Between the two sheets thermal insulation of 40 mm thick polyurethane hard-foam shall be provided. The dimensions of the shelter shall be according to container standards, the length shall be at least 10 feet. The shelter shall be complete with all electrical installation, power distributors and signal and RF- distribution boxes. A built-in battery compartment shall be provided. For air conditioning equipment, respective openings and supports shall be provided. The outside shelter surfaces shall be coated with warning paint acc. to RAL 2002. Foundation drawings with static calculation shall be provided after contract award.

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3.1.3 *Environmental Requirements*

3.1.3.1 *Wind Resistance*

The DME antenna structures shall withstand wind velocities up to 160 km/h for operation (survival 200 km/h, survival 144 km/h with 1.5cm ice load).

3.1.3.2 *Ice Loading*

Ice loads up to 5cm thickness shall not cause any damage to shelters and antenna structures.

3.1.3.3 *Antenna Cover*

Antenna elements shall be protected by fibreglass- reinforced polyester covers

3.1.3.4 *Indoor Temperature*

Indoor equipment shall operate within their specifications:

Ambient temperature	-10°C to + 55°C
Relative humidity	<95% in the range of –10°C to +35°C <60% in the range of + 35°C to 55°C

3.1.3.5 *Outdoor Temperature*

Outdoor equipment and material shall withstand without any damage or deformation:

Ambient temperature	-40°C to + 70°C
Relative humidity	up to 100%

3.1.3.6 *Environmental Requirements*

Outdoor elements, structures, shelters and others shall be designed and constructed to withstand site typical effects as salt, rain, hail, thunderstorms, attacks of small to medium animals (e.g. dogs, rabbits), without damage or noticeable deformation.

3.1.3.7 *Temperature Variation*

All equipment shall operate within their specifications (without damage or malfunction) during Temperature variation of up to 20°C within 24 hrs.

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3.1.4 System Configuration

3.1.4.1 Equipment Cabinet

The system concept shall be, to accommodate at least two independent equipment sections in a single 19" standard size cabinet. The power supply and charger units shall be integrated into the electronic equipment, and shall be housed in the same cabinet. The respective safety regulations shall be observed. Heat protections between the power supply and the electronic equipment shall prevent heat dissipation from penetrating the electronic part.

3.1.4.2 Monitoring

3.1.4.3 The monitoring system shall be modular and shall allow alarm threshold settings by Portable Maintenance Data Terminal (PMDT – Laptop) entry only. Modularity

3.1.5 Quality Assurance

3.1.5.1 Certifications

Bidder to provide a letter from OEM to confirm that the ILS system offered is compliant with ICAO Annexure 10.

3.1.5.2 Burn-In

Components and sub units shall undergo "burn- in" tests during production.

The complete system shall be subjected to "burn- in" testing at a temperature of **50°C at least 48 hrs.**

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3.1.6 Description

3.1.7 Main Features of the Equipment

It shall comply with the ICAO specifications in Annex 10, 5th ed. July 1996 and Eurocae MPS Ed. 57, standard 1 as applicable; also refer to the FAA – E-2721/13 specifications.

It shall be housed in a single 19" cabinet (standard height 1730 mm, width 580 mm, depth 610mm).

It shall be powered both from mains and from standard 48 V batteries, with built - in battery charger as an option.

The equipment shall have the capability to be powered from a collocated VOR or DVOR beacon with +48 V DC.

It shall be fully dual, being composed of two 100W (approach & terminal) or 1 kW transponders (en route) and two microprocessor-controlled monitoring systems.

It shall be completely modular.

Its distance information shall be accurate: up to ± 15 m.

Its output pulse shape shall be digitally controlled by a microprocessor to the transponder itself.

Its monitoring shall be dualized and microprocessor-controlled.

It shall automatically provide ICAO performance checks at programmable intervals and results shall be stored/displayed/printed at operator's choice.

It shall be capable of executing a resident diagnostic program to help the operator in locating a failure.

It shall be controlled through a Personal Computer (PC) at beacon site, which can be duplicated at remote site; the PC can also be a portable unit to be connected only when required for maintenance reasons.

It shall be possible to connect it to a Remote Control and Monitoring Network System, for interfacing and controlling different nav aids facilities.

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3.2 Engineering

MODULARITY: all circuits shall be divided into functional modules; all modules shall be accessible from the front of the equipment.

INTERCONNECTIONS: extensive use shall be made of printed board back planes, flat cables and semi-rigid coaxial cables.

IDENTIFICATIONS: all modules shall be easily recognizable by their P/N and a three-letter code permanently marked on easily readable surfaces. All modules, cables and connectors shall be marked and keyed to prevent incorrect connection.

COOLING ~ no blowers shall be required to remove heat from the equipment, extensive use shall be made of aluminium extruded heat sinks

PRINTED BOARDS: two-or multilayer printed boards with plated-through holes shall be used throughout the equipment; high frequency circuits shall be implemented in microstrip technology.

RF SHIELDING - all RF circuits shall be accurately shielded in casting or extrusion boxes.

CORROSION: protection against corrosion and fungus shall be obtained by means of suitable materials, finishes and coating.

SAFETY: the equipment shall be designed in order to be intrinsically safe for the user. No dangerous voltages except mains shall be used. All modules or places, where a dangerous voltage may be accessible, shall be firmly protected by covers not removable without use of tools and clearly marked with warning readouts.

PROTECTIVE DEVICES: special protective circuits shall be built-in in order to ensure that any failure in the equipment does not cause further damage to other parts or components.

COMPONENTS ~ only high-quality components shall be used, in order to meet the reliability requirements.

3.3 Reliability

In the calculation of the beacon reliability, all alarms of the monitors shall be considered primary and the monitors in parallel configuration so that both monitors must detect an alarm at the same time in order to trigger a changeover or a beacon shutdown.

The failure rate of the various modules shall be calculated in accordance to the MIL-HDBK-217E in Ground Fixed conditions at an ambient temperature of 20 °C and of 55°C.

The MTBF shall be:

MTBF at 20°C	Dual station, no maintenance	over 12 000 hours
MTBF at 55°C	Dual station, no maintenance	over 8 000 hours

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3.4 Manufacturing, Testing and Quality Assurance

All stages of design, manufacturing and testing of the equipment shall meet the requirements of "International Quality Standards" as ISO 9000 and AQAP 1113.

All modules of DME shall be submitted to a burn-in procedure and shall be tested according to specifications by means of computer-controlled test equipment.

3.5 Technical Documentation

The technical manual delivered with the system shall be composed of three parts: operator's instructions, maintenance instructions; part lists and schematics. All results of final tests on the equipment shall be collected in the Acceptance Test Data Book, which shall be delivered with the equipment.

3.6 Installation

Installation of the equipment shall be simple and shall be accomplished in few hours even by unskilled personnel with a minimum of tools; the equipment shall only require a minimum of shelter room. Details of standard installation shall be included in the technical manual.

3.7 Operation

Operator's interface shall consist of a PC terminal connected with the equipment. Control of the equipment and of its parts, tests and measurements, diagnostics and pre setting of all equipment's parameters shall be performed via keyboard. The basic control of the beacon (on/off, changeover) shall be possible, however, even when the PC is disconnected.

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3.8 Maintenance

Due to the solid-state design, the high stability provided by the digital circuitry and the fail-safe monitoring action, routine maintenance shall not be required.

Automatic routine check of beacon performances according to ICAO specifications shall be obtained through the control system both from site and from the remote control location, and shall be programmed to be automatically performed and recorded at fixed intervals. In both cases, the results shall be printed on request.

Troubleshooting and repair shall be based on the following concepts:

- on-equipment, on-site maintenance involves fault isolation down to module level and replacement of the faulty module. It shall be performed by low-level maintenance personnel by means of the built-in diagnostic capability of the monitoring system. In most cases the failure shall be traced down to module level even from remote site. Repair shall require standard tools only.

Mean Time to Repair (MTTR) shall be below 25 minutes; no single repair shall exceed 90 minutes.

- Off-equipment off-site maintenance shall involve troubleshooting and repair on the faulty modules down to component level. A higher skill level shall be required and work shall be executed in a suitable equipped Technical Centre.

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4 FUNCTIONAL Requirements

4.1 General

The DME shall consist of the following main parts.

- In/Out system
- control system
- monitoring system
- transponder system
- RF path
- external connection interface system
- power supply system

The DME In/Out system shall be totally modular, it shall be able to meet any type of requirement that may arise in an installation; this system shall make it possible to:

- control and monitor the beacon using a Personal Computer and/or Control Panel

The main parts of the In/Out system shall be

- Control & Status Board (CSB)
- Personal Computer

At the local site, the beacon-operator interface shall consist of:

- Control Panel
- Personal Computer (optional), which allows the operator to completely control and monitor the beacon

The In/Out system shall be handled by the CSB unit, which shall control and handle the communication with remote monitoring and control sites, which takes place through telephone line(s).

The I/O devices that interface the operator in a remote site shall be a Remote Monitoring and Maintenance System with Personal Computer.

The remote Personal Computer shall allow the operator to completely control and monitor the beacon. It shall perform the same operations of the local site Personal Computer.

The Control Panel shall consist of three sections: the first section carrying the beacon operating status LED's and the buzzer (engaged when the beacon shutdown occurs), the second section carrying the beacon commands, and finally the third section carrying additional indications.

The interface terminal with the operator used for equipment control, monitoring and maintenance shall consist of an IBM compatible Personal Computer.

At the local site the communication between the PC and the equipment shall take place through a serial RS-232C connection by means of the CSB unit.

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The PC shall communicate directly with the local site equipment through a telephone line by means of a modem or through a Remote Monitoring and Maintenance System. The RMMS-System shall communicate with the local site by means of a telephone line and the PC shall be linked to the RMMS through an RS-232C serial line.

4.2 Control and Monitor System

The Control and Monitor System of DME shall be designed to achieve the goals of maximum integrity, versatility and performance. It shall be composed of two (dualised) monitor boards, each equipped with a microprocessor.

Each monitor shall be a complete, independent programmable DME instrumentation set composed of an interrogator and a Signal Analyzer capable of performing all tests and checks required for routine maintenance and for automatic diagnostics.

The transponder control shall take actual control of the beacon by means of two independent microprocessors with dualized data buses, connected with the other circuits through suitable interface cards.

The structure shall be conceived such as to avoid that any single failure whatever impair the system capability of providing correct DME service to aircraft. Multiple failures in dual units, or failures whose origin cannot be assessed with certainty, shall bring to equipment shut down.

The microprocessors of the dualized monitor system and of both transponders shall also communicate by means of the CSB unit, with the I/O devices (Local and Remote) and shall provide the Operator with complete control over the equipment, fully automatic pre-setting of all operational parameters and continuous updating about equipment status, measurement, results etc.

The software program resident in the microprocessors shall be responsible of the total equipment management.

Its structure shall be shared in elementary activities; each of them dedicated to a particular task.

4.2.1 Routine Check

When the ROUTINE CHECK is launched the monitors shall perform a series of measurements on all parameters relating to the transponder connected to the antenna, to the dummy load or to the monitors, depending on which one was selected by the operator. The results of these measurements shall then be displayed on the video.

The measurement list shall come after the list of the main parameters preset for correct interpretation of the Routine Check.

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These parameters shall be:

- CHANNEL AND MODE
- REPLY DELAY
- DEAD TIME
- SHORT ECHO SUPPRESSION
- THRESHOLD LONG DISTANCE ECHO
- SENSITIVITY N

The Number of Samples for Average calculation (NSFA) shall depend on the parameter to be measured; usually, its value ranges between 1 and 1000. The tests that shall be selected for the transponder connected to the antenna are listed below with the messages that shall be displayed on the screen:

PULSE SPACING: spacing between the pulses in a pair measured using the half amplitude points on the rising edge of the two individual pulses in the pair as reference. The final result of the measurement shall be obtained by averaging 100 measurements, with an accuracy of ± 20 ns.

PEAK POWER OUTPUT ~ peak power output of both the pulses making up the reply or squitter pair; the final result, shall be the average of 100 single measurements, with an accuracy of ± 0.5 dB.

TRANSMISSION RATE: transmission rate is defined as the number of pulse pairs transmitted per second (pp/s); it shall be selected to cover a range of values from 800 ± 50 pp/s up to 4800 ± 150 pp/s or from 2700 ± 90 pp/s up to 4800 ± 150 pp/s. The final result, obtained by averaging 10 single measurements, has an accuracy of ± 20 pp/s.

PEAK POWER DROOP: maximum power output droop with respect to the average power value the result shall be obtained

- by averaging the results of 1000 measurements performed on the transmitted pulses.

REPLY EFFICIENCY: reply efficiency defined as the percentage ratio between the number of interrogation pulse pairs and the number of reply interrogation pulse pairs. The measurement shall be performed by counting the replies to 50 interrogations per second with an interrogation level of 6 dB above the sensitivity threshold; the final result, shall be obtained by averaging 100 single measurements, with an accuracy of $\pm 2\%$.

TRANSMITTER FREQUENCY: the value of the transmission frequency relating to the set channel shall be measured by a counter. The final result shall be obtained by averaging 10 single measurements, with an accuracy of ± 50 ppm (parts per million).

PULSE SHAPE: the shape of the individual pulses making up the reply pair shall be obtained by measuring the rise time, decay time and duration; the result shall be obtained by averaging the results of 50 single measurements.

REPLY DELAY VARIATION WITH LEVEL: reply delay variation in relation to the interrogation level, where the reply delay is the interval of time between the interrogation pulses, generated by the interrogator (MIN), and the replies. The measurements shall be performed for an interrogating level of -10 dBm, -30 dBm, -50 dBm, -71 dBm and 3 dB above the sensitivity threshold set for the receiver, the final result shall be obtained by averaging 100 single interrogations with an accuracy of ± 20 ns.

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SENSITIVITY N: receiver sensitivity shall be obtained by measuring the reply efficiency with an interrogation level of ± 3 dB, ± 2 dB and ± 1 dB above and below the sensitivity threshold set for the receiver; the final result shall be obtained by averaging the results of 100 single measurements.

BANDWIDTH: bandwidth shall be obtained by measuring the reply efficiency at a frequency which differs from the nominal frequency of the operating channel by ± 200 kHz and by using the pulses with an interrogation level of 3 dB above the sensitivity threshold set for the receiver; the final result shall be obtained by averaging the results of 100 single measurements.

ADJACENT CHANNEL REJECTION: adjacent channel rejection shall be obtained by measuring the reply efficiency at a frequency which differs from the nominal frequency of the operating channel by ± 900 kHz, using pulses with an interrogation level of -10 dBm. The final result shall be obtained by averaging the results of 100 single measurements.

DECODER: - the correctness of the decoding operations performed by the processor module shall be ascertained by measuring the reply efficiency for pulse pairs with a spacing that differs from the nominal value by ± 1 μ s with an interrogating level 1 dB above the sensitivity threshold set for the receiver, the reply efficiency for pulse pairs with spacing that differs from the nominal value by ± 2 μ s with an interrogating level of -10 dBm and the reply efficiency for individual pulses with an interrogating level of -10 dBm. The final result shall be obtained by averaging the results of 100 single measurements.

DEAD TIME: dead time shall be obtained by measuring the reply efficiency for the interrogations which fall 2 μ s before and 14 μ s after the end of the dead time activated by a previous interrogation with an interrogation level of -70 dBm. The final result shall be obtained by averaging the results of 100 single measurements.

RECOVERY TIME: recovery time shall be obtained by measuring the reply efficiency relating to an interrogation, with an interrogation level 1 dB above the sensitivity threshold set for the receiver, that falls 9 μ s after a single pulse interrogation, with an interrogating level 60 dB above the sensitivity threshold. The results of this test shall not be significant if the short echo suppression circuits are activated. The final result shall be obtained by averaging the results of 100 single measurements.

ECHO SUPPRESSION: echo suppression shall be estimated for both long and short echo suppression. To check that the long echo suppression circuits function correctly, an interrogation with a level 3 dB above the anti-echo activation threshold set shall be used to trigger the anti-echo circuits and the reply efficiency (NSFA of the measurement equal to 1) shall be measured in the following three ways:

- with interrogations that simulate the presence of echo pulses with an interrogation level 10 dB above the anti-echo circuit activation threshold set and a delay with respect to the trigger equal to: (Nominal Interrogation Spacing)+ (Anti-echo Duration)- 6 μ s. The final result shall be obtained by averaging the results of 100 single measurements.
- with interrogations that simulate the presence of echo pulses with an interrogation level 2 dB greater than the anti echo activation threshold set and delay, with respect to the trigger, which is the same as the delay above.

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- with interrogations that simulate the presence of echo pulses with an interrogation level 2 dB greater than the anti-echo circuits activation threshold set, and with a delay, with respect to the trigger, equal to (Nominal Interrogation Spacing)+ (Anti-echo Duration)+ 6 us

IDENTITY CODE: identity code set for the beacon expressed in Morse code, NSFA of the measurement equal to one.

IDENTITY TIMING: identity code timing shall be obtained by measuring the duration of the dots, dashes and spaces in the character, the interval between two characters, the repetition rate and the code period (1350 Hz frequency) between two pairs that identify the code.

4.2.2 Presetting

All equipment functional parameters shall be stored in the controllers EEPROM. Almost all parameters shall have default values, with the exception of the following ones:

- CHANNEL AND MODE
- IDENTITY CODE
- REPLY DELAY

These three parameters will have to be necessarily defined by the operator; otherwise there will be no possibility of powering the beacon on. Should the EEPROM be loaded with only the default values without those that still have to be defined by the operator the software will warn the operator with the DEF PARAM message. The modification operations of the beacon functional parameters shall be accessed only after entering the control program with a third level password.

LIST OF MODIFIABLE PARAMETERS

PARAMETER	POSSIBLE SELECTIONS	DEFAULT VALUE
CHANNEL & MODE	Channel: 1 to 126 Mode: X or Y	None None
IDENTITY CODE	Max. 4 characters <64 dots long	None
TRANSMISSION RATE	800 to 4800 or 2700 to 4800	2700 to 4800
REPLY DELAY	Mode X 35 to 75 µs in steps of 0.5 µs	None IP Mode Y~ 46 to 75
DEAD TIME	0 to 150 µs in steps of 1 µs	60 us
SHORT ECHO SUPP.	Enabled (ON) Disabled (OFF)	ON
THR. LONG DIST. ECHO	0 to -60 dBm	in steps of 0 dBm 10 dBm
SENSITIVITY N	-74 dBm to -91 dBm in steps of 1 dBm	-91 dBm

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PARAMETER	POSSIBLE SELECTIONS	DEFAULT VALUE
ANTIECHO DURATION	50 to 300 μ s in steps of 5 μ s	100 μ s
MORSE MODE	MASTER CODE, MASTER TRIGGER MASTER TRIG. SLAVE CODE, SLAVE TRIGGER	
INDEP. IDENT. RECOV.	Never (NO) Through signal from associated equip- ment (ON SIGNAL) Code not received from associated equipment (ON SENSING)	NO
REDUCED POWER OFF (0 dB)	ON (-3 dB)	OFF
MONITORS LOGIC 2 MONITOR	1 MONITOR	1 MONITOR
STANDBY MODE HOT	NORMAL	NORMAL
REPLY DELAY Alarm thld.: ± 0.1 to 0.4μ s - ± 0.1 μ s Alarm delay: 1 to 10 s in 4 s in steps of 250 ms	Type of alarm: PRIMARY	PRIMARY
PULSE SPACING Alarm thld.: fixed at ± 0.25 μ s Alarm delay: 1 to 10 s in 4 s steps of 250 ms	Type of alarm: PRIMARY ± 0.25 μ s	PRIMARY
REPLY EFFICIENCY Type of alarm: fixed at 66% Alarm delay: fixed at 10 s	Type of alarm: PRIMARY or SECONDARY, 66 % 10 s	SECONDARY
IDENTIFICATION Alarm delay: 1 cycle	Alarm type: PRIMARY or SECONDARY, 1 cycle	SECONDARY
PEAK POWER OUTPUT Alarm thld.: fixed at -3dB Alarm delay: 1 to 10 s in 4 s steps of 250 ms	Alarm type: PRIMARY -3 dB	PRIMARY
TRANSMISSION RATE Alarm thld.: fixed at -80pp/s Alarm delay: fixed at 10 s	Alarm type: PRIMARY or SECONDARY, -80pp/s 10 s	SECONDARY

RESTART PARAMETERS

Number of attempts: 0 to 3

1 attempt delay:	60s
20 to 3600s in steps of	1 s
2 attempt delay'	120s
20 to 3600s in steps of	1 s
3 attempt delay:	180s
20 to 3600s in steps of	1 s
Restore speed:	60 to 3600s 240 s
in steps of	60 s

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SYSTEM CONFIGURATION YES or NO	Battery power supply on - YES
Mains power supply: YES or NO	YES
Association to a VHF equipment: YES or NO	YES
ROUTINE CHECK PERIOD	1 hour to 90 days in steps DD-MM of 1 hour or both fields
PASSWORD	5 alphanumeric characters A (w/o 10M)

4.3 Remote Control and Monitoring System

The Remote Control Maintenance and Monitoring Network System (RMMS) shall consist of modular elements that shall allow:

To monitor and control a main equipment (for example: DME) and associated equipment (for example: VOR), through a Personal Computer and by means of Remote Status Indicator (RSI) via the 110 unit housed in DME.

To communicate with one or more Remote Control Sites through leased and dial-up telephone lines.

The RCMS shall be composed essentially of the following elements:

- DME CSB UNIT (I/O Manager)
- PERSONAL COMPUTER WITH SOFTWARE
- CTU (Status Indicator for Control Tower)
- RCSE (Remote Control & Status Equipment)
- REMOTE PERSONAL COMPUTER

The RMMS shall be designed and manufactured in order to provide a standard mean suitable to locally and remotely control a main equipment which shall be provided with a serial RS-232C port, to transfer outside some information and to acquire from outside some controls.

These signals, managed by a processor, shall be ruled by software running on a local PC, or by PC placed in remote sites and connected to leased or dial-up telephone lines.

Besides the above-mentioned digital signals, the RMMS shall be able to manage other parallel ON/OFF (I/O) signals coming from associated (either local or remote) that can be used to operate indicators and to send commands.

The RMMS operation shall be based on the components modularity, to make it easy to modify and implement the network in the future (Centralized Remote Control System) and to use it through standard interfaces and procedures in order to control a main equipment an/or associated equipment.

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The digital information exchange among the various sites (consisting of indications and commands) shall be made on normal telephone lines of the leased or dial-up type.

The connection through leased lines shall be of the point-to-point type; therefore the remote site provided with this connection shall be in direct touch with the CSB unit.

The connection of remote sites on dial-up lines shall be established by means of the SV (Supervisory) software program that automatically shall be provided to up-date in sequence the memories of the RSI unit when an event occurs.

The up-dating of the archive of the Personal Computer shall take place automatically every time the PC is switched-on and the program starts, or when the operator enters the "control" option of the program by means of the password, or manually under the operator's request with the option "maintenance" of the program.

If a remote site is programmed to control the main equipment, it can exercise control with the program by sending to the main station the commands that shall be, available on the front panel of the RCSE UNIT, by pressing the relevant push-button

The RCSE unit shall display through LEDs the operation status of the beacon.

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4.4 Technical Specifications

DME technical specifications are listed in the following table

DME TECHNICAL SPECIFICATIONS

RF frequency stability	0.0015%
Pulse Shape	
Rise Time	2.5 us, -1 us, +0-5 us
Duration	3.5 us +1-0.5 us
Decay Time	<3.5us
Pulse Spectrum	The pulse spectrum of the modulated signal shall be such that during the pulse, the output power contained in a 0.5 MHz band centred to +1-0.8 MHz with respect to the nominal channel frequency, shall not be greater than 20 mW while in the same band centred to +1-2 MHz, it is not greater than 0.2 mW
Pulse Spacing	+P 0.1 us
Output Power	≥ 1 KWp
Peak Power Droop	<1 dB
Transmission Rate	Variable from 800 ±50 pp/s to 4800 ±150 pp/s, or from 2700 ±90 pp/s to 4800 ±150 pp/s; in both cases, never less than 800 ±50 pp/s
Receiver Sensitivity	< -91 dBm as measured at DME output connector
Receiver Sensitivity Variation with Decoding	With ±1µs different spacing, with respect to the nominal value, the sensitivity changes of <1 dB; non decoded pulses with ±2 us different spacing
Receiver Sensitivity Variation with interrogating load	with interrogating load ≤ 90 % of maximum transmission rate, the sensitivity changes of 1dB
Receiver Sensitivity Variation with frequency	With ±200 kHz different frequency with respect to the nominal frequency. the sensitivity changes of <1 dB
Interrogation Rejection on Adjacent channel	With ±900 KHz different frequency with respect to the nominal frequency, the interrogations are suppressed by the receiver
Recovery Time	With an unwanted single pulse, 8 µs before the pair, the sensitivity shall change of <1dB
Dead Time	Adjustable in 1 µs steps from 50 to 150µs, nominal 60µs
Identity Code Check	International Morse Code:
Dots	Dots duration between 100 ms and 160 ms ±5 %
Period	741 µs ±2 %
Equalization pulses	100 µs ±10 µs
Replay Delay variation with interrogating level	±0.2 µs "bias" ±0.2 µs "noise", for 95% of DME/N interrogations with an interrogating level from -5 dBm to -80 dBm; ±0.4 us "bias" and ±1 us "noise" for -80 dBm to -91 dBm DMEIN interrogations
Reply Efficiency	>70 %

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5 ANTENNA SYSTEM

The antenna for DME shall be a 9 dB gain omni directional.

The antenna shall be a sturdy, corrosion-protected unit well suited to withstand adverse environmental conditions like high wind speed (up to 160 Km/h), extreme temperatures (-50 up to +70 deg/C), salt fog, rain, hailstones (up to at least 1 cm diameter), snow and ice (2.5 cm max.).

The antenna shall be easily mounted on top of a steel pole; its radome shall house two monitor probes to be connected with the equipment monitors.

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