SPECIFICATION OF AN NDB SYSTEM

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In this contribution is present specification of non-directional beacon NDB 436, which is used in air navigation. This beacon operates in the frequency bands MF or LF. We present a simplified functional block diagrams beacon NDB 436 and to the following scheme describes the principle of its operation. Detailed analyzes the antenna system, the transmitter and monitoring equipment of beacon. Further we state the possibilities for operational use beacon NDB 436.
K e y w o r d s: signal, monitoring, antenna, radio beacon

1 INTRODUCTION

Non-Directional Beacon NDB is a radio transmitter that works in the frequency bands MF or LF. Beacon sends a signal non-directional that is modulated by identification signal in Morse code rhythm. NDB beacon is used in aviation for the designation of flight routes and instrument approaches. NDB navigation system is one of the oldest air navigation systems currently in use. Its advantages are low cost of acquisition and operation. We analyze the operating principle NDB beacon on the basis of a simplified functional block diagrams. We conducted an analysis of the system using a technical description of NDB 436 from Thales.

2 GENERAL INFORMATION

NDB (Non Directional radio Beacon) system is a radio transmitter that transmits RF signals in the frequency range between 190 and 1700 kHz. The airborne equipment provides the pilot and/or flight crew with navigational information. NDB beacon has been the first operational radio navigation aid, and it is still widely adopted by aviation operators because of its low purchase and life-cycle cost and its inherent simplicity of use. NDB is used also as a backup in case of failure of the NAVAIDS primary systems. This information on the board (ADF – Automatic Airborne Direction Finder) is provided by means of a rho-theta polar coordinate system on an indicator, e.g. Heading Indicator, in which a rotating needle continuously indicates the aircraft heading with respect to the beacon. [1]

NDB coverage determines the maximum distance at which the bearing accuracy is acceptable and the identification tone is still recognizable. It is measured according to the signal/noise ratio at the ADF receiver input. When the signal/noise ratio is too low, the bearing pointer of the airborne instrument is unstable and/or destabilized and the identity tone is distorted and covered by noise. The field strength received by ADF at any given distance depends on the effective power radiated by the transmitting antenna and on the surface-wave attenuation rate. This attenuation depends on the electrical properties of the terrain. Each NDB installation is classified in relation to its coverage and is defined by multiples of 25 NM (nautical miles). Transmitter power must not exceed what is needed to obtain the required coverage, in order not to interfere with other stations on the same or adjacent frequencies. The radiated signal does not contain any intrinsic bearing information; therefore the accuracy of the system depends only on the airborne receiver accuracy and on RF propagation anomalies. [1]

3 TECHNICAL INFORMATION OF BEACON NDB 436

The NDB 436 system ground beacon is composed by equipment NDB 436 (Transmitter /Monitor/ Local Control), antenna tuning unit ATU 436 (Coils, Motor unit, ATU control board), power supply BCPS-CE unit (AC/DC converter – battery charger), antenna system and I/O system. The NDB equipment cabinet consists of two symmetrical half-shells, one of which is wall-mounted and the other is hinged on the first and opens as a vertical book. The standard configuration of the NDB 436 equipment is consists of two transmitters, a dual monitor system, an adapter and relay-over ADP board, a Local Panel Control, two + 5V, ± 15V, DC/DC converter DCD and dummy load. The modules of the equipment are housed in a half-shell for transmitter 1 and in other half for transmitter 2. All printed boards are assembled flat, so that the circuits are accessible with no need for extenders. Simple flat ribbon cables and plug-in connectors provide the electrical connections for low level analog/digital signals among all modules and by wires for power supply. Cables lay on the both half-shell and connect all modules. The coaxial cables used for the output RF power provide the terminator with type “N” coaxial connectors. [1]

The Local Control and Status Unit (LCSU) are located on the front half-shell, as well as Transmitter n.1, Monitor n.1 and DC/DC Converter n.1. The CSB board (Control Status Board module) of the LCSU unit, combined with the INC module (Indication and Control), are mounted on the front half-shell. The control front panel of the INC module is equipped with indicators: the indicators, for check of beacon functions. The wall-mounted half-shell houses the change-over relay and power/signal distribution ADP module and the 50 Ohm dummy load composed by four resistors protected by a cover. Transmitter n.2, Monitor n.2 and DC/DC Converter n.2 are also located in the fixed half-shell. [1]

The NDB 436 system consists of hardware and of software that largely controls the hardware. Transmitter and monitor are controlled by microprocessors. Both communicate with the LCSU which is controlled by its own microprocessor. The transmitter generates, modulates and controls the RF power signal of the NDB. [1]

4 SPECIFICATION OF BEACON NDB 436

4.1 Principal of operation

The NDB system is a non directional radio beacon radiating vertical polarized signals in the low/medium frequency range (200-1750 KHz). The navigational signal doesn´t contain any coded information except for a Morse code, periodically repeated, which identify the transmitter station. The airborne ADF supplies to the pilot the indication of maximum signal strength, i.e. the direction of the ground station. The main problems of NDB system are related to the radio electrical signal propagation mode and to the subsequent operational limitations. Due to the frequency band used, the antenna system consists of unavoidably short antennas, with very low radiation efficiency. A suitable Antenna tuning unit (ATU) is used to maximize the antenna tuning and to compensate little changes in electrical environmental characteristics. [1]

4.2 Monitoring circuits

The monitors (MON) can perform:

- Measurements and evaluate the quality of the transmitter signal using appropriate probes on TRS output in antenna or in dummy load. Antenna radiation signals measurements coming from ATU are evaluated as well.
- Execution of appropriate actions in case of fault detection (equipment changeover or shutdown)
- Ensuring its own performance which is not dependent of environmental conditions and component aging (selfcheck)

The monitoring system has the purpose to check the correctness of the radiated signal. When two monitors are used, they can cause equipment change over or shut down either whenever one of them senses a parameter out-of-tolerance condition or whenever both of them sense a parameter out-of-tolerance, according to operator selection. Monitor correct operation is continuously self-check. The monitors (MON) can perform measurements and evaluate the quality of the transmitter signal using appropriate probes on TRS output in antenna or in dummy load. The probe signals, after detection, are analog-to-digital converted and then processed by the monitor CPU. [1]

4.3 Mechanical description

The block diagram of a complete system is shown in Fig. 1 and includes of the following option parts:

- Modem and telephone line ESD protection, for connection with Remote Control
- Electrical switchboard with automatic switches for mains and 48Vdc for overload or short-circuits protection
- Isolated Transformer (and DC/AC inverter in case of black-out of mains)
- SSU by means of suitable sensors manages (up to 16 inputs) the site status parameters (anti-intrusion, internal temperature, mains black-out, etc.). Also detect the obstruction lights lamps current and take place the alarm signal when one of the lamps burns out. [1]

4.4. Antenna system

The antenna radiates omni directional RF power in the horizontal plan. The radiated power pattern shows that the field strength is a minimum when the aircraft is over the vertical of the antenna (provides a “fix” position.[1] The antenna is much shorter (typically 20 m long) than the wavelength and therefore it has a low efficiency (the taller the antenna, the better the performance). Furthermore, it varies according to the environment condition. In order to tune the antenna impedance it is necessary to connect a variable tuning unit which also provides an antenna impedance matching transformer.

A range of antenna shapes are possible, like “L”- “T”- Ring – Star – Mast – Tower - Whip etc. The most used is the metallic lattice mast-pylon type. Antenna radiating resistance is low (for mast approx. 20m, is typical 0.2 Ω). The effective radiated power is proportional to the ratio between the antenna and ground resistance. Therefore it is essential to obtain the lowest possible ground resistance (< 4Ω). The standard antenna system is composed of Counterpoise, Antenna (pylon lattice tower for 20m Thales antenna) and Antenna support frame. [1]

4.5 Power supply system

The equipment can be powered using a mains supply from 220Vac – 15% to 240 Vac + 10 % (48-68 Hz) or using an external nominal voltage of +48 VDC supply. The equipment power supply system consists mainly of AC/DC converter mounted on BCPS-CE unit. The 54Vdc output voltages are used also to supply the DCD modules (regulated switching 48VDC/+5V±15V DC converters) on NDB 436 equipment and ATU 436 unit. The BCPS-CE unit includes two switching AC/DC modules which are voltage regulated and in parallel connection, a module with circuit (Battery supervisory) of battery protection and the terminal bar for cables inputs. These modules are stabilized at the typical voltage of 54Vdc. This also permits recharging of the floating battery within reasonable time. An uninterruptible power supply is thus available if mains power fails. [1]

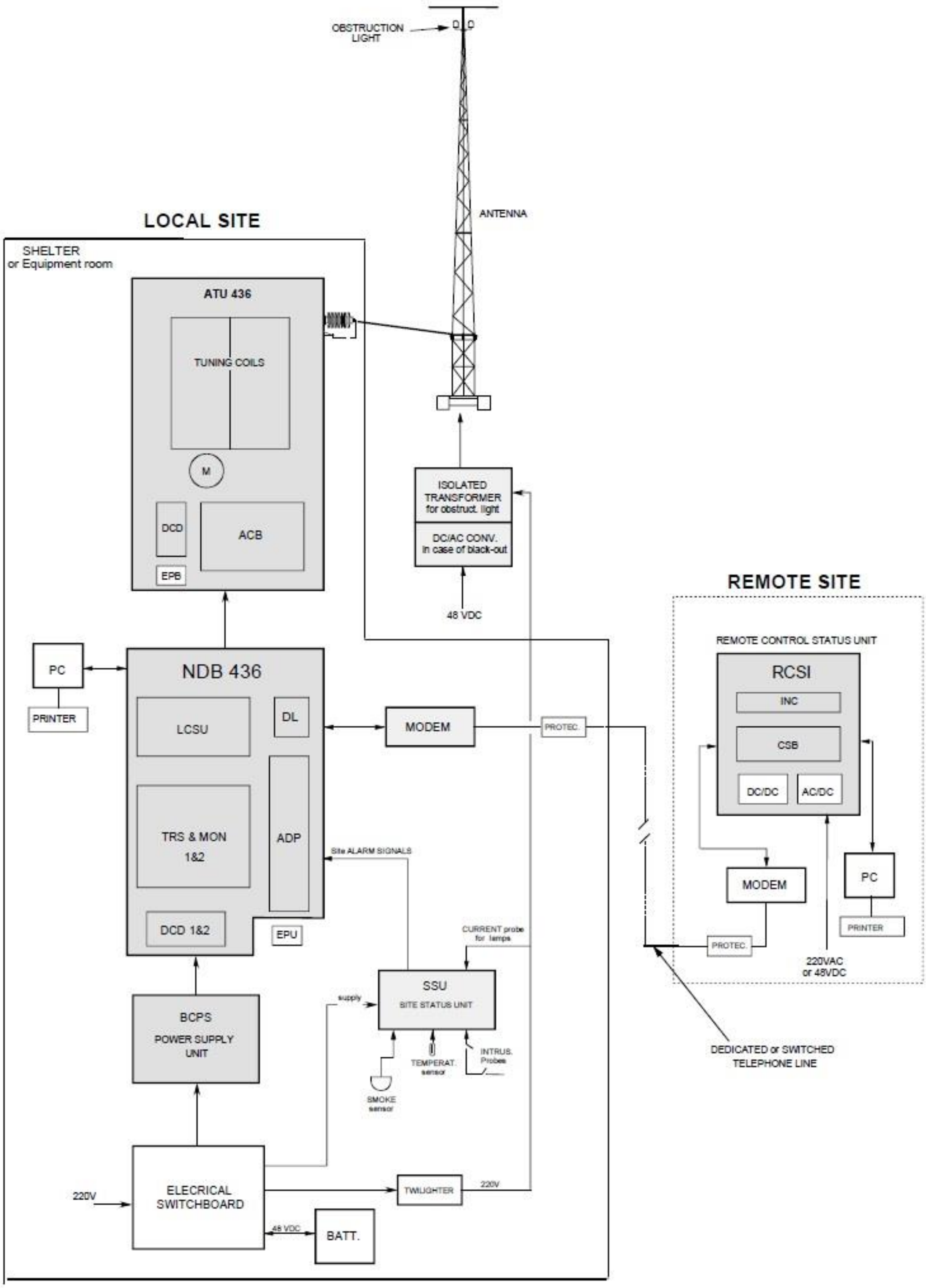

Fig. 1 Typically installation – Block diagram [1]

5 CONTROL OF TECHNICAL STATUS

During the hardware control the option is selected from the Main menu which leads to display the page containing the options relating to functionality verification of the input and output ports and the control emulating the serial lines.

During the flight test documentation is recorded by the printer connected to the PC or in a file on the PC. The data recorded during the commissioning and flight check should be recorded and stored in a reference file. The same procedure should be followed when performing further checks, so the data recorded can be compared with the original flight check data. Routine tests will verify the proper performance of the NDB transmitter monitor and ATU. This performance test should be run after operator´s consideration. If any tests fail, repeat the tests two or three times to verify the failure. [1]

6 CONCLUSION

Non-directional beacons NDB are radio navigational aids that are used for indication of flight routes and precise approach landing. Despite the fact that the measurement accuracy of the currency angle beacon by radio compass on board the aircraft is not very high, so NDB beacons are suitable for indication routes and precise approach landing under suitable weather conditions. Because of their reduced accuracy protection zones of flight routes are quite large. This is considered disadvantage, because the flight routes must be sufficiently distant from each other, as well as any obstacles must be sufficiently distant from the axis of the runway. The great advantage of these beacons is low operating costs. In accordance with the European Navigation concept ECAC NDB beacons will probably be decommissioned in 2015. They will be gradually replaced by global navigation satellite system GNSS.

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