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RADIO NAVIGATIONAL AIDS

500 ILS

510 / 520 LOCALIZER

TECHNICAL MANUAL

RADIO NAVIGATIONAL AIDS

500 INSTRUMENT LANDING SYSTEM

510 / 520 LOCALIZER

Rev. A/2016-03-11

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Warning

This is a class A product. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

LIST OF TABLES

TERMS AND ABBREVIATIONS

AC	*Alternating Current*
AC/DC	*AC-to-DC Converter*
ADC	*Analog-to-Digital Converter*
ADN	*Antenna Distribution Network*
AM	*Amplitude Modulation*
BITE	*Built-In Test Equipment*
CAN	*Controller Area Network*
CDI	*Course Deviation Indicator*
CFB	*Cartesian Feedback*
CL	*Course Line*
CLR	*Clearance*
CPLD	*Complex Programmable Logic Device*
CRS	*Course*
CSB	*Carrier with Sideband*
CSP	*Control Status Panel*
DAC	*Digital-to-Analog Converter*
DC	*Direct Current*
DC/DC	*DC-to-DC Converter*
DDM	*Difference in Depth of Modulation*
DDS	*Direct Digital Synthesis*
DS	*Displacement Sensitivity*
DSP	*Digital Signal Processing*
EMU	*Environmental Monitor Unit*
FFM	*Far Field Monitor*
FFMC	*Far Field Monitor Controller*
GMA	*Glide path Modulation Amplifier*
GP	*Glide Path*
GUI	*Graphic User Interface*
I/Q	*In-phase / Quadrature*
ICAO	*International Civil Aviation Organization*
IDENT	*Identification*
IFB	*Interface Board*
ILS	*Instrument Landing System*
LAN	*Local Area Network*
LCD	*Liquid Crystal Display*
LED	*Light Emitting Diode*
LMA	*Localizer Modulation Amplifier*

LMI	*Local Maintenance Interface*
LOC	*Localizer*
LRU	*Line Replaceable Unit*
MCN	*Monitor Combiner Network*
MCU	*Micro Controller Unit*
MKR	*Marker*
MON	*Monitor*
MSG	*Modulation Signal Generator*
NF	*Near Field*
NFM	*Near Field Monitor*
NM	*Nautical Mile*
PLL	*Phase Locked Loop*
PMDT	*Portable Maintenance Data Terminal*
PMU	*Power Monitoring Unit*
RF	*Radio Frequency*
SBO	*Sideband Only*
SCU	*System Controller Unit*
SDM	*Sum of Depth of Modulation*
SMPS	*Switched Mode Power Supply*
STB MON	*Standby Monitor*
STDBY	*Standby*
SYN	*Synthesizer*
TCXO	*Temperature-Controlled Crystal Oscillator*
TFT	*Thin Film Transistor*
THD	*Total Harmonic Distortion*
TX	*Transmitter*
UART	*Universal Asynchronous Receiver/Transmitter*
USB	*Universal Serial Bus*
VAU	*Voice Amplifier Unit*
VGA	*Variable Gain Amplifier*
VSWR	*Voltage Standing Wave Ratio*
WPM	*Word Per Minute*

1. GENERAL INFORMATION

1.1. INTRODUCTION

This technical manual describes the type 510 LOC (*single-frequency Localizer*) and the type 520 (*two-frequency Localizer*) manufactured by MOPIENS, Inc. The purpose of this document is to provide information required to install, operate and maintain the 510 LOC and 520 LOC equipment (single and dual configurations) when used together with the relevant Antenna System technical manual.

Included are a general description and specifications, block diagram theory, detailed theory of operation, operating procedures, standards and tolerances, periodic and corrective maintenance procedures, parts list, installation procedures, schematics, and other diagrams.

1.2. EQUIPMENT DESCRIPTION

The 510/520 LOC is part of the MOPIENS 500 Instrument Landing System (ILS). The 510/520 LOC provides lateral guidance to an aircraft during its final landing approach. The LOC antenna system radiates amplitude modulated (AM) synthesized pattern by 90 Hz, 150 Hz tone and 1,020 identification code. This pattern, when facing LOC from the end of runway entry, is stronger with 150 Hz tone from right-hand side and 90 Hz tone from left-hand side.

The localizer equipment is typically installed in an equipment shelter located off to either side of runway, approximately 70m from the centerline and about 300m from the stop end of the runway. The antenna array is located on the extended runway centerline.

Both 510 LOC and 520 LOC are designed and manufactured to meet or exceed the requirements of International Civil Aviation Organization (ICAO) as described in the Annex 10, Volume I. The 510/520 LOC can support ILS Facility Performance Category I, II and III, provided that relevant siting criteria are met and proper installation is carried out.

The 510/520 LOC are fully solid-state, and use modern digital techniques to minimize the number of adjustable controls. Extensive BITE is available throughout the equipment, and a maintenance computer permits monitoring and adjustment of the equipment.

The 510/520 LOC are designed for continuous and uninterrupted operation and can be configured as a single equipment or dual equipment for high reliability and availability.

Also the 510/520 LOC are designed for protection from:

- High values of VSWR caused by loss of tuning or disconnection of antennas, problems in coaxial cables or disconnection of them.
- Surge protection (transient voltage suppression) and physical interfaces to various units such as LMI, EMU, remote voice, RCU and PMDT via RS-232, USB, modem (telephone line) and Ethernet.
- Lightning protection.

The dual equipment version can be configured in either a hot standby or a cold standby mode. For a Category III ILS, the dual equipment and hot standby configuration is required.

1.2.1. ILS OVERVIEW

A complete Instrument Landing System is composed of:

- A LOCALIZER SYSTEM, providing lateral guidance in reference to the runway center line.
- A GLIDE PATH SYSTEM, providing vertical guidance in reference to the glide path angle .
- MARKER BEACONS, providing indications of particular distances to the runway threshold.

1.2.2. LOCALIZER PRINCIPLE OF OPERATION

The localizer principle of operation is based on the measurement of the difference in the depth of modulation (DDM) between a 90 Hz and 150 Hz sinusoidal signal. The localizer equipment generates a RF signal in the frequency range of 108 to 112 MHz and the RF signal is fed into a localizer antenna system. The radiation from the localizer antenna system produces a composite field pattern which is amplitude modulated by a 90 Hz and 150 Hz tone. The radiation field pattern produces a course sector with one tone predominating on one side of the course and with the other tone predominating on the opposite side. When an observer faces the localizer from the approach end of a runway, the depth of modulation of the radio frequency carrier due to the 150 Hz tone is predominate on the observer’s right hand on that due to the 90 Hz tone is predominate on the observer’s left hand.

This signal provides the lateral position information to an aircraft approaching the runway. The aircraft interprets this signal and displays them on the cockpit indicator usually a CDI. The needle of the CDI measures the difference in depth of modulation (DDM) of the 90 Hz and 150 Hz signal and deflects left or right in accordance with the position of aircraft with respect to the runway centerline. When the needle is to the left (or right), the pilot has to fly left (or right) until the needle points to the center. The needle comes in the center when the DDM is zero, signifying that the aircraft’s approach coincides with the physical runway centerline.

The localizer provide for the simultaneous transmission of an identification signal, specific to the runway and approach direction, on the same radio frequency carrier or carriers as used for the localizer function. The transmission of the identification signal does not interfere in any way with the basic localizer function. The identification signal is produced by Class A2A (keyed audio tone in AM) modulation tone of 1020 Hz.

1.2.3. 510/520 LOCALIZER OVERVIEW

The 510 LOC is a single-frequency and 520 LOC is two-frequency localizer equipment. Both 510 LOC and 520 LOC can be configured as either single or dual equipment. Figure 1-2 and figure 1-3 show the family tree diagram for single and dual equipment for 510LOC. Figure 1-4 and figure 1-5 show the family tree diagram for single and dual equipment configuration for 520 LOC.

1.2.4. 510/520 LOCALIZER DESCRIPTION

A 510/520 Localizer system comprises of:

- A LOC Transmitter/Monitor subsystem
- An Antenna Distribution Network
- A Monitor Combiner Network
- A LOC Antenna Array
- Near-field Monitor antenna (optional)

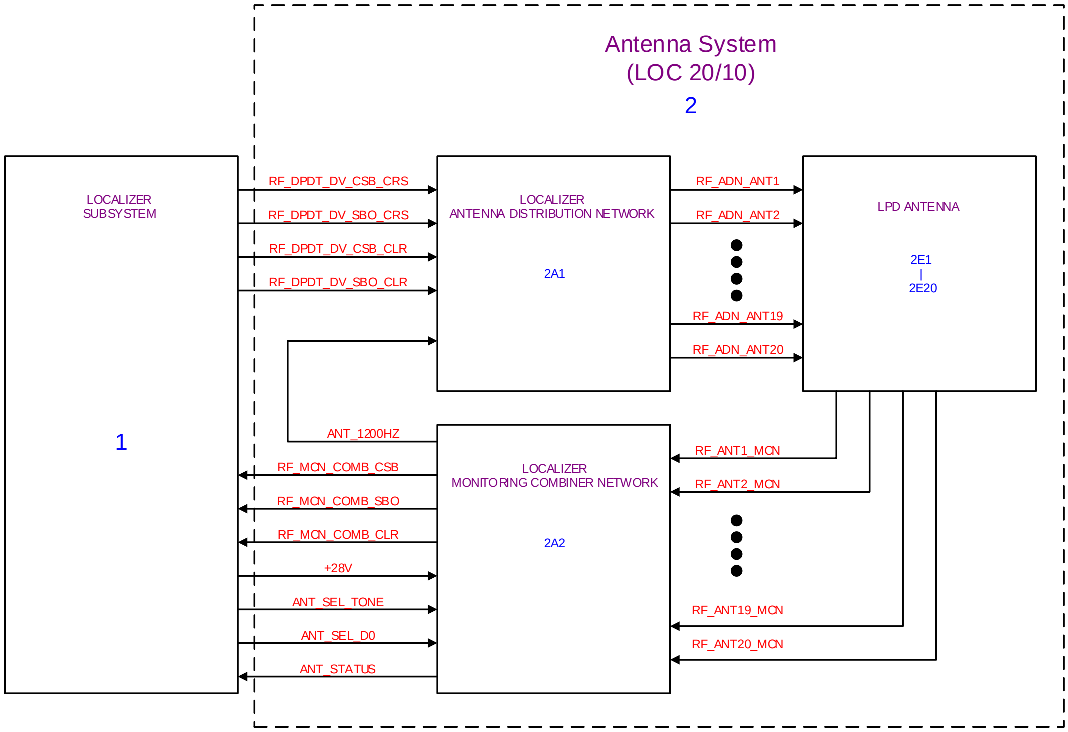

Figure 1-1. Typical 520 Localizer with 20/10 LPD Antenna System

The Localizer subsystem consists of the localizer transmitter/monitor subsystem. The output of the transmitter goes to the Antenna Distribution Network (ADN) for feeding the antenna array. The Monitor Combiner Network (MCN) takes input from the signal being radiated in air by the antennas and after combining it to course and clearance signal sends to the Monitor (MON) subsystem. The MON subsystem analyzes all the signal parameters to ensure the integrity of LOC signal. Figure 1-1 shows typical 520 Localizer System.

Each LOC transmitter consists of three units namely synthesizer (SYN), localizer modulation amplifier (LMA) and modulation signal generator (MSG). The SYN uses a very stable TCXO to generate the RF carrier signal. The MSG provides two modulation signals of 90 Hz and 150 Hz to generate the composite signal for Course and Clearance. The LMA is the modulation amplifier which performs the amplitude modulation and power amplification of the signal.

The power supply system provides all the necessary power source and different output voltages to the respective units. A control and monitoring subsystem provides system status information and allows monitoring functions locally and remotely. Figure 1-2 shows the simplified block diagram of the 510/520 Localizer.

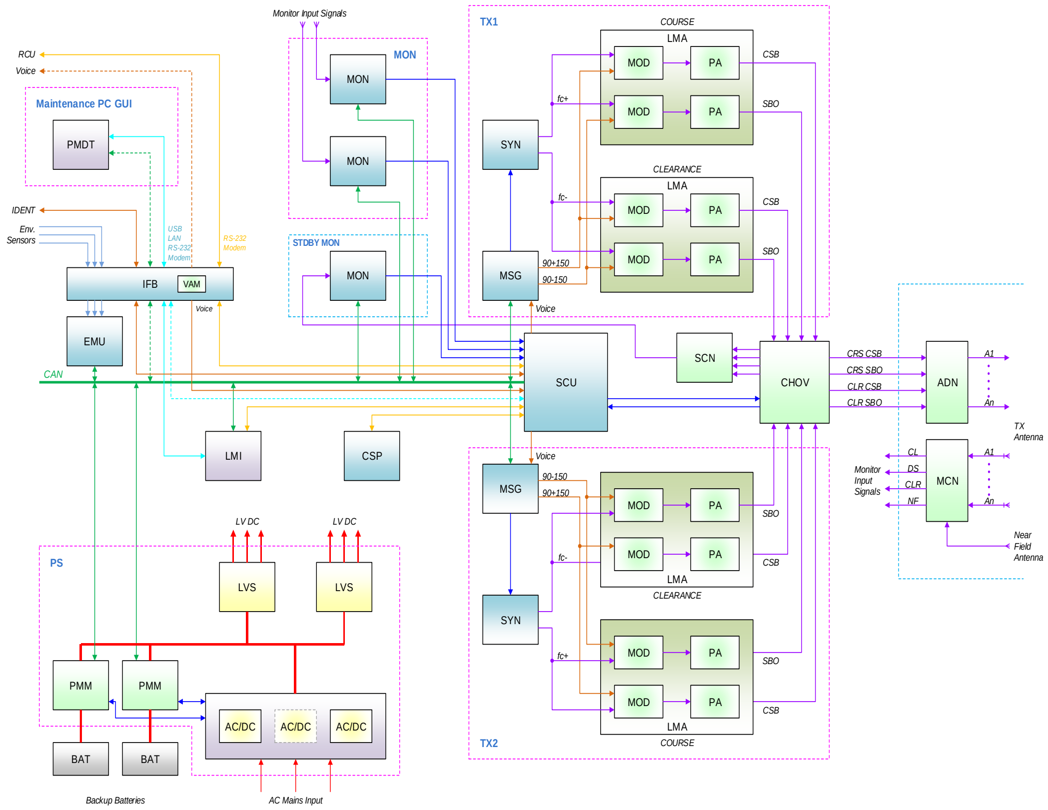

Figure 1-2. Simplified Block Diagram of 520 LOC

1.3. EQUIPMENT IDENTIFICATION

The 510/520 LOC is part of a family of comprehensive and latest-generation ILS equipment. The versions share many features, modules and principles of operation, and differ only slightly in frequency and purpose. All of the versions are available in a single or dual equipment configuration and can be used with a set of antenna configurations also. A single equipment version is denoted with a suffix –S, followed by the type number, i.e. 510S LOC refers to a single-frequency, single equipment version localizer.

- 510S LOC: a single-frequency single equipment localizer
- 520S LOC: a two-frequency (capture effect) single equipment localizer
- 510 LOC: a single-frequency dual equipment localizer
- 520 LOC: a two-frequency (capture effect) dual equipment localizer

1.4. COMPOSITION AND IDENTIFICATION

The Table 1-1 shows the various units and the related reference labels of the 510/520 LOC for single and dual equipment configurations. The features and function of the units are common to all configurations with only difference in the quantity of some specific units.

Table 1-1. Reference Labels, 510/520 LOC

Unit	Label	Single-Frequency		Two-Frequency	
		510S	510	520S	520

AC to DC Converter Unit	AC/DC	1	2	1	2
Control and Status Panel	CSP	1	1	1	1
DC to DC Converter Unit	DC/DC	1	2	1	2
DC to DC Converter Unit-A	DC/DC-A	1	2	1	2
Environment Monitoring Unit	EMU	0(1)	0(1)	0(1)	0(1)
Far Field Monitor Controller	FFMC	0(1)	0(2)	0(1)	0(2)
Interface Board	IFB	1	1	1	1
Local Maintenance Interface	LMI	0(1)	0(1)	0(1)	0(1)
Localizer Modulation Amplifier	LMA	1	2	2	4
Modem	Modem	1	2	1	2
Modulation Signal Generator	MSG	1	2	1	2
Monitor	MON	1	2	1	2(3)
Power Monitoring Unit	PMU	1	2	1	2
Synthesizer	SYN	1	2	1	2
System Controller Unit	SCU	1	2	1	2
Voice Amplifier Unit	VAU	0(1)	0(1)	0(1)	0(1)

**The number in ( ) is optional.*

1.5. PHYSICAL DESCRIPTION

The 510/520 LOC subsystem is housed in an enclosed, floor-mounted type cabinets.

The cabinet material is durable and non-corrodible. Major assemblies or LRUs are designed to be completely removable from their enclosures without disassembly. The cabinet has two doors. The front door provides access to the front panel, LRUs and all the other assemblies of the subsystem. The rear door provides access to the back of the backplane and cables and connectors of the assemblies. With the front door open, all the maintenance operations can be performed from the front of the equipment. The locking, hinged door protects the front of the cabinet.

The front control panel is on the front door of the cabinet. On the front-door, the LMI is mounted to provide a quick access to the system maintenance as well as the basic system control and status information.

Figure 1-3 shows the equipment cabinet front and rear view.

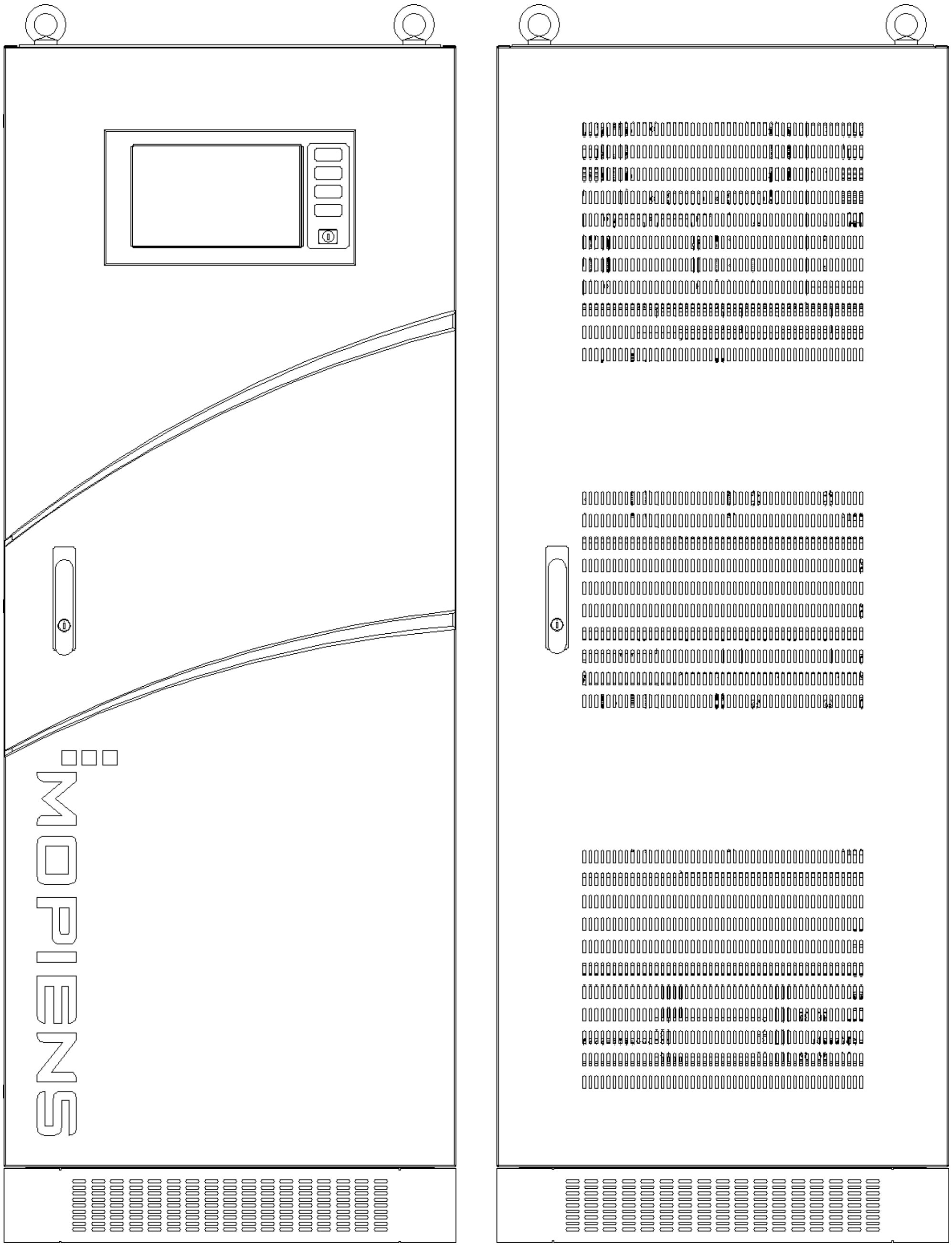

Figure 1-3. Equipment Cabinet Front and Rear View

The cabinet is self-ventilated. It has got perforated metal plate on top and bottom so no forced ventilation is required. The top of the cabinet has four threaded holes for screwing in the eyebolts that are used to lift the equipment.

The standard configuration of the 510/520 LOC is composed of two transmitters, a dual monitor, a dual power supply and control and monitoring unit. The equipment assemblies are housed in a single 19-inch standard cabinet. The steel cabinet can accommodate three assembled subracks and plug-in 6-U or 3-U Eurocard printed circuit boards with depth of 200 mm or 6-U size modules with metal shield case of 300 mm depth.

Each module or unit is designed to be plugged-in to each designated slot. If it is inserted into a wrong place, it does not fit as a special keying-mechanism prevents it for protection. The modules and units with printed circuit boards has hot swap and hot plug-in circuits and mechanism so that it can be plugged and unplugged even when the equipment is powered on.

The RF output connector to the antenna distribution network and the monitor combining network are located on top of the cabinet. The RF components of the modules are enclosed in metal housings.

The RF components of the modules are enclosed in metal housings for prevention of electronic crosstalk and electro-magnetic interferences (EMI) as well as for protection of human body. Thanks to such design, it does not cause interference to the equipment and systems nearby airport and has no harmful effect on human body and equipment.

Figure 1-4 and Figure 1-5 show the interior layout of 510 LOC and 520 LOC equipment cabinets respectively, showing the location of the major LRUs and modules.

Each subrack can be unscrewed and pulled out. All the LRUs are plug-in types with either ejectors or captive screws. Each LRU slides and can be easily pulled out by its handles or ejectors.

1.6. MECHANICAL DESCRIPTION

The 510/520 LOC equipment comprises of a 19” standard rack cabinet. The Figure 1-4 and Figure 1-5 show the location of the LRUs and modules in 510 LOC and 520 LOC respectively. The figures refer to dual equipment configuration which uses two transmitters for redundancy. Each transmitter is an independent functional subsystem.

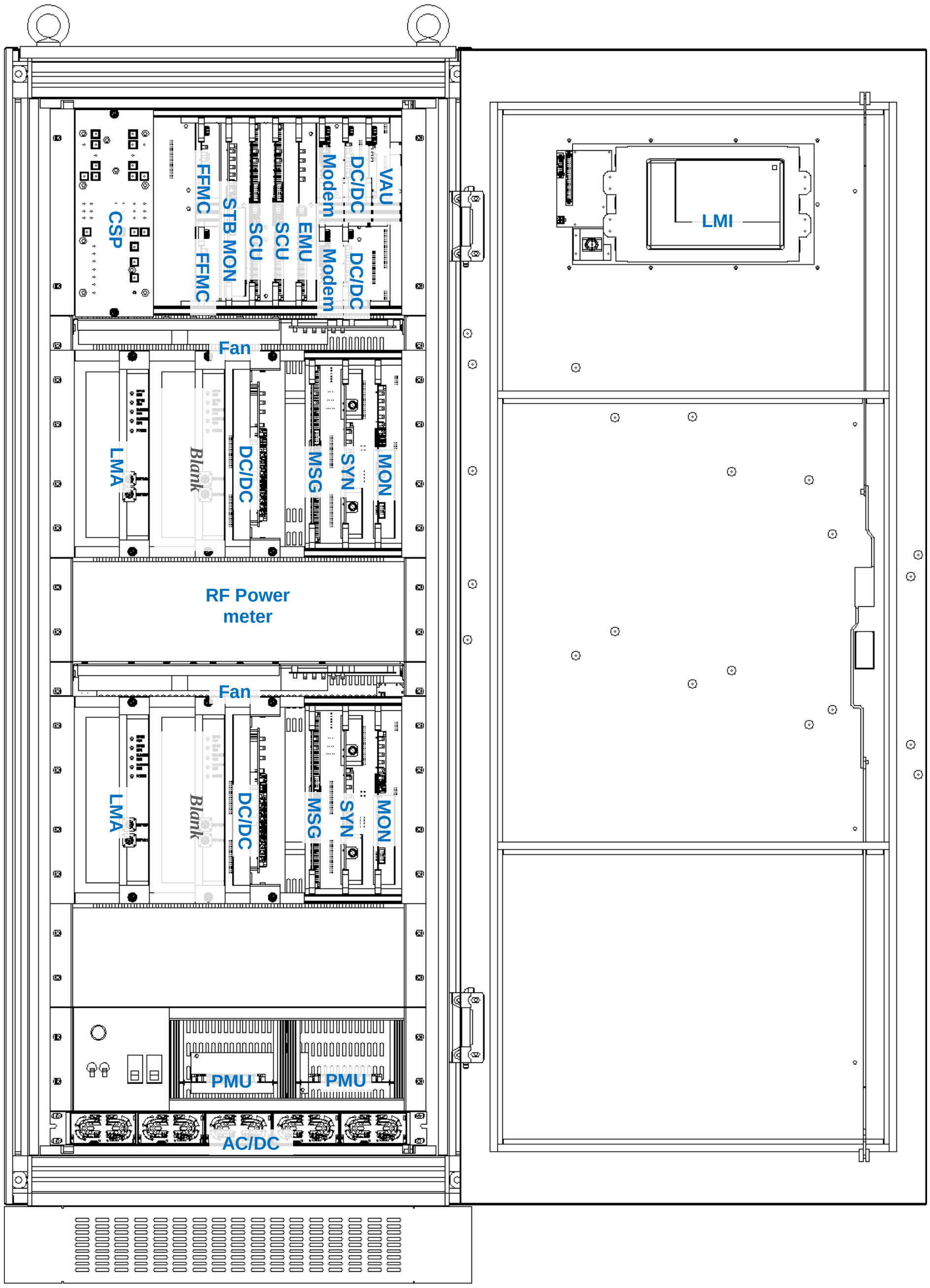

Figure 1-4. Interior layout of 510 LOC (Front View)

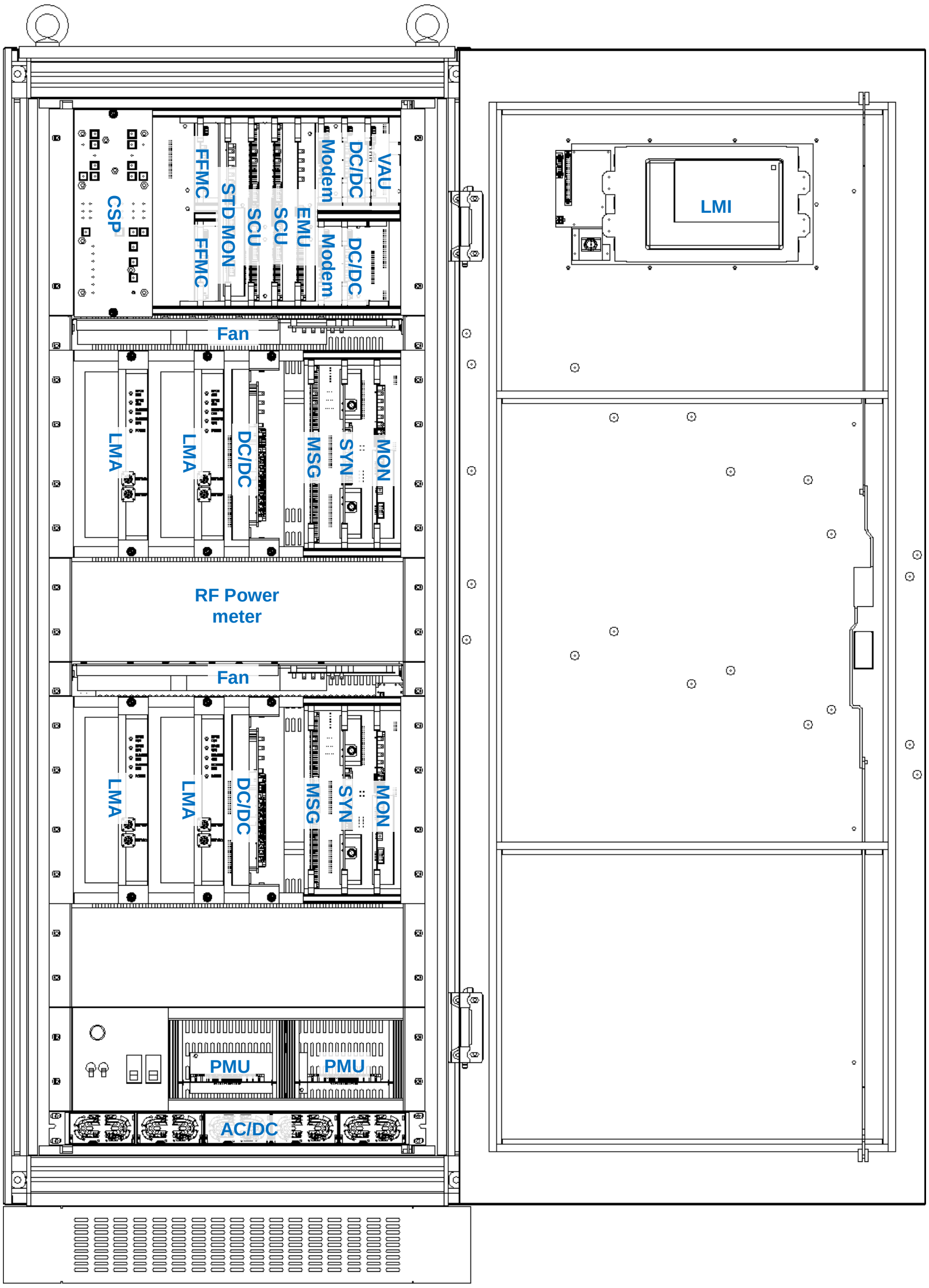

Figure 1-5. Interior layout of 520 LOC (Front View)

1.7. FUNCTIONAL DESCRIPTION

1.7.1. OVERVIEW

The 510/520 Localizer equipment consists of dual transmitters and monitors whereby each monitor performs monitoring for both the transmitters. The hardware is based on RF and digital assemblies and the software that controls them.

1.7.2. TRANSMITTER

The transmitter subsystem generates the RF signal that is fed to the antennas. Each transmitter consists of three units: Frequency Synthesizer (SYN), Localizer Modulation Amplifier (LMA) and Modulation Signal Generator (MSG). For two-frequency system, two LMAs are required, one for course transmitter and one for clearance transmitter. The LMAs for course transmitter and clearance transmitter are identical and interchangeable.

Figure 1-6 shows the block diagram for transmitter subsystem.

The SYN generates the RF carrier signal for the course and clearance using a crystal based RF oscillator. It uses a very stable temperature controlled crystal oscillator (TCXO) combined with Direct Digital Synthesis (DDS) to provide very accurate signal. To maintain phase/frequency coherence across the entire system, a single common reference frequency source is used for the course CSB, course SBO, clearance CSB and clearance SBO.

The MSG is responsible for producing the composite CSB and SBO modulation envelopes for course and clearance. It provides the modulation signals for carrier which are 90 Hz and 150 Hz sinusoidal signals, 1020 Hz on/off keyed sinusoidal signal and optional voice signal.

The Localizer Modulation Amplifier (LMA) provides the amplitude-modulated signals for CSB and SBO in LOC. LMA consists of two amplifiers which are “Cartesian-loop feedback” controlled. One amplifier is meant for the CSB signal and the other for the SBO signal. The carrier signal which is generated by the frequency synthesizer is amplitude-modulated, phase-compensated, and phase offset adjusted in the modulator. The amplitude modulated signal is then filtered and amplified to the necessary level to drive the power amplifier. The power amplifier outputs are designed to withstand infinite VSWR without damage.

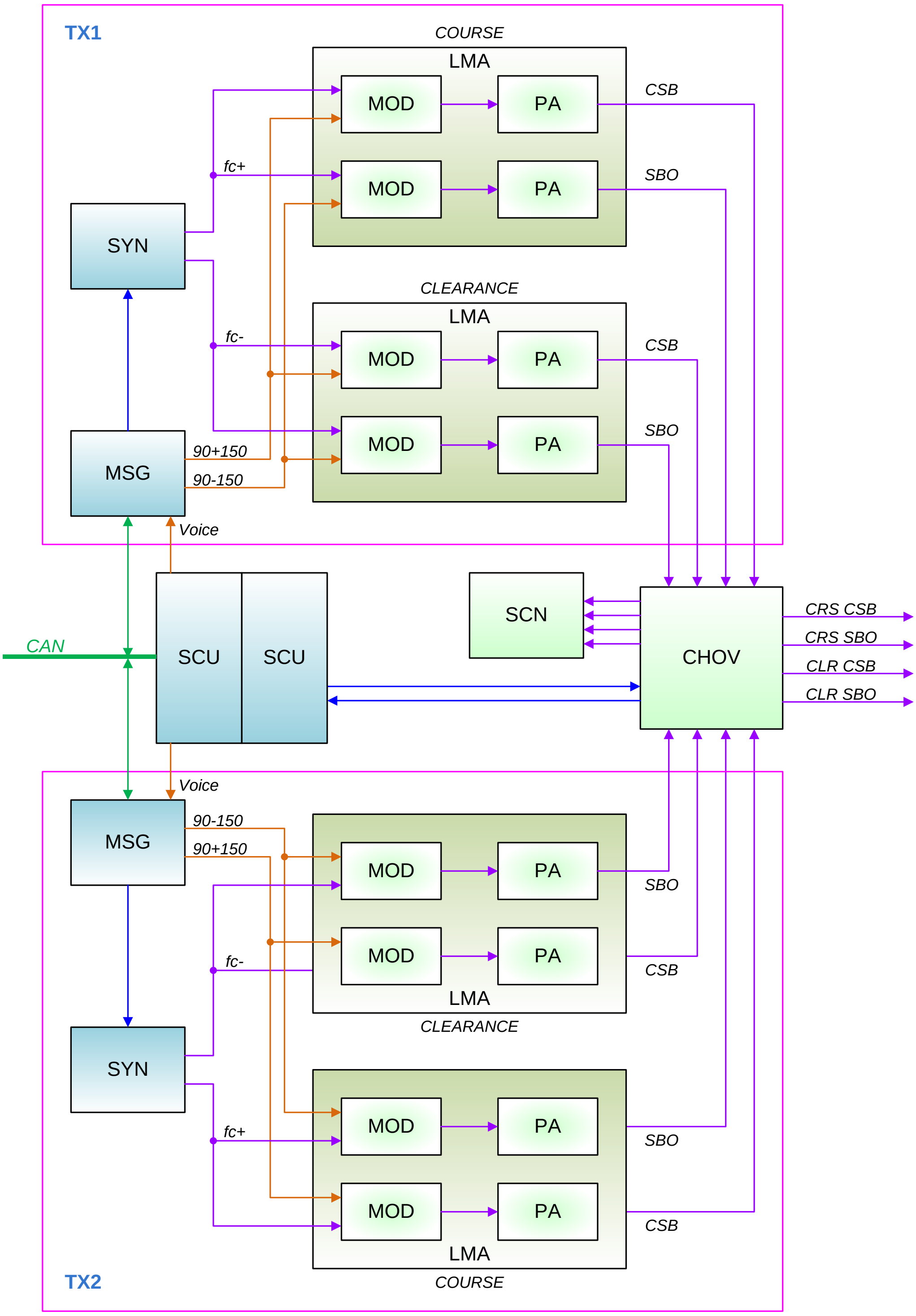

Figure 1-6. Transmitter Subsystem Block Diagram, 510/520 LOC

The RF signals produced by the transmitters are supplied to the changeover section. The changeover section consists of a number of modules including the RF coaxial relays, RF switches for monitor local oscillator select, power meter line sections, dummy loads and low passes filters, etc., which are mounted on the rear of the equipment cabinet.

The RF coaxial relays are used to connect the CSB and SBO outputs from one transmitter to the antenna while the other is connected to dummy loads. The relays are controlled by a signal from

SCU.

The power meter line sections are used to sample the RF output to the external DUCU and measure the power output and modulation depth. Suitable power measuring elements depending on the power level are inserted into the line section and the sampled voltage is provided to the power meter via the select switch assembly mounted on the front of the cabinet. For measurement of modulation depth using external test instrument, a pickup (sampling) element can be inserted instead.

1.7.3. MONITOR

The Monitor System comprises Integral Monitoring and Near-field Monitoring. Far-field Monitor is recommended for CAT II and is mandatory for CAT III operations.

The Monitor can be either a single or dual redundant system. Two monitors watch for the active main transmitter. The standby monitor, which is optional for CAT III LOC is plugged in the AUX subrack and is dedicated for monitoring the standby transmitter.

It generates alarms in case of transmitter or antenna system failure. The monitor analyzes the ILS parameters such as DDM, SDM, RF level, and voltage, current, temperature of subrack and compares with operator programmed threshold values. If any parameter is beyond the tolerance values, an alarm is generated.

A high integrity integral monitoring system is incorporated in the localizer system. This system provides fault detection by monitoring the transmitted signal. It also initiates changeover to standby transmitter or shutdown of transmitter in the event of an out-of-tolerance condition.

The near field monitor can be configured in conjunction with the integral monitor. It receives the real field signal being transmitted and detects changes due to any misalignment of the antenna system which could affect the signal.

A Far-field Monitor Controller module receives data from the Far-field Monitor via a dedicated modem line or RS232C interface. The FFM parameters are passed on to the monitor and appropriate action is taken depending on the values of the parameters.

1.7.4. POWER SUPPLY

The block diagram of Power Supply subsystem is shown in Figure 1-7.

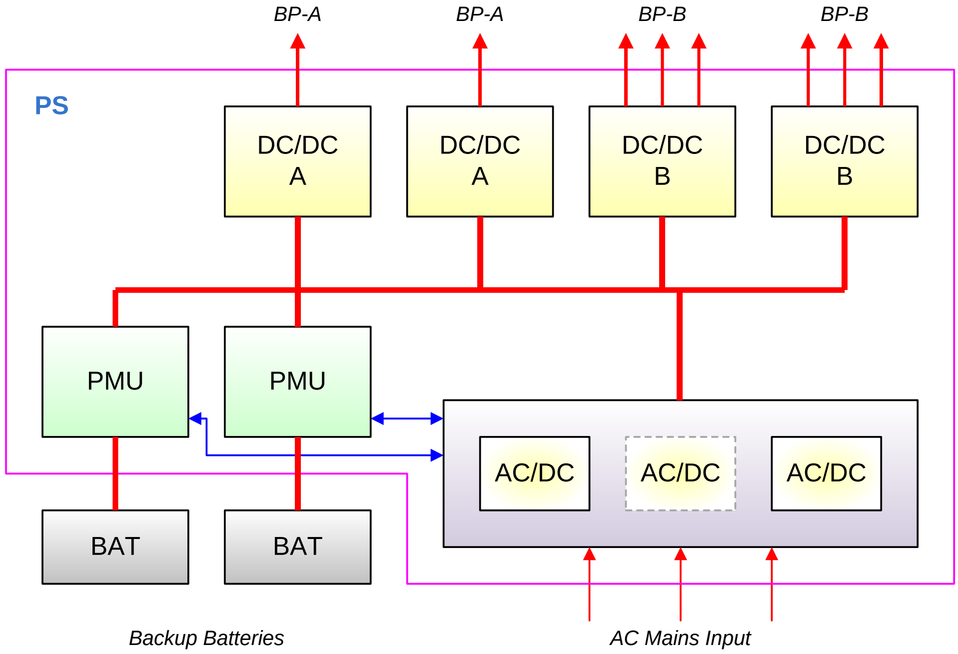

Figure 1-7. Power Supply Subsystem Block Diagram

The Power Supply system consists of:

- AC/DC converter, which takes 110V/220V AC mains power input and converts it into 28V DC. The 28V power source is fed to the multi-voltage DC/DC converters and also used to charge external backup batteries.
- DC/DC converter, which receives +28V DC input from either AC/DC or Battery backup source and converts to the output voltages of +5V, +8V, +15V, -15V, +28V and +50V which is used for VOR/DME only.
- DC/DC-A converter to provide power to the auxiliary electronics subrack by converting +28 V DC to +5V, +15V and -15V output voltages.
- Power Monitoring Unit (PMU), which monitors the output voltages, current, temperature and battery status.
- Two backup batteries, which provide DC 24V and are connected in parallel with the AC/DC converter outputs to provide uninterrupted power supply.

The AC/DC power supply units are placed at the bottom of the cabinet. The primary power source of the equipment is the commercial AC line power (mains). For uninterrupted continuous operation, a secondary power source by backup batteries is supported. The primary power and secondary power run in parallel without switching so that “no-break” operation is possible.

1.7.5. CONTROL AND MONITORING

- The Control and Monitoring subsystem of the 510/520 LOC provides system status information and allows monitoring functions to be performed locally and remotely. The major building blocks of Control and Monitoring subsystem are the SCU, CSP, LMI, IFB and EMU.
- Figure 1-8 shows the block diagram of Control and Monitoring subsystem.

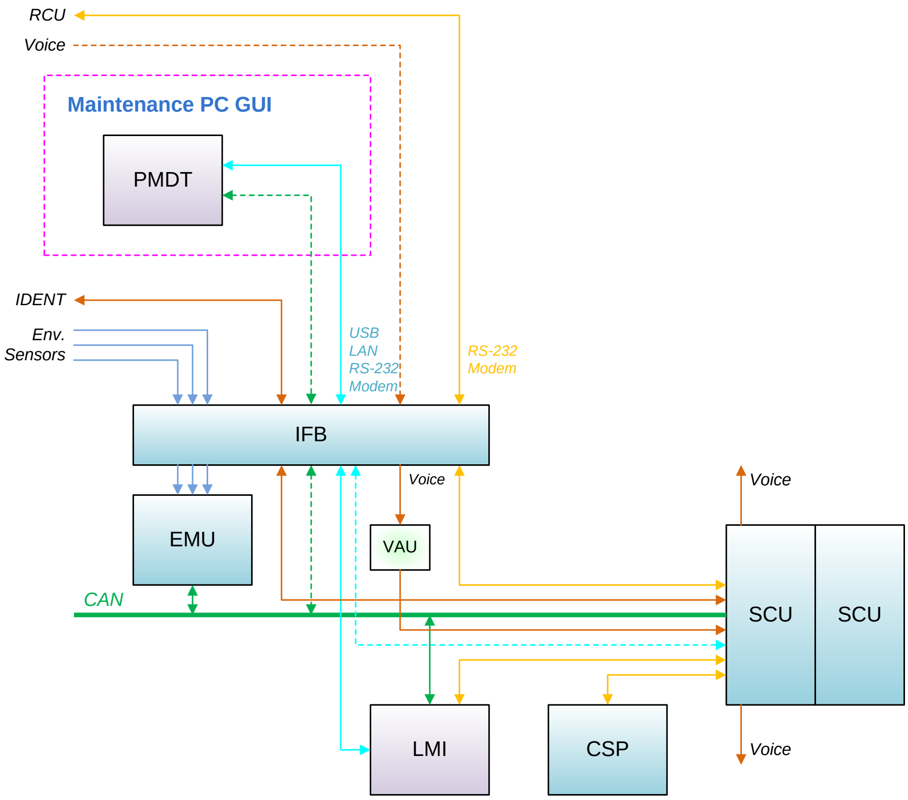

Figure 1-8. Control and Monitoring Block Diagram, 510/520 LOC

The System Controller Unit (SCU) provides control and monitoring of all system units. The SCU monitors the alarm/fault signal lines from all internal units. Also it exchanges data with some units such as MSG, MON, PMU, EMU and external components such as RCU and PMDT. The Control Area Network (CAN) bus is used for communication with internal units. The RCU and PMDT exchange data with SCU via RS 232C, modem or Ethernet interface.

When the SCU senses alarm signals from MON units, it initiates a transfer of the equipment or shutdown. In case of a dual equipment system, the voting logic in the SCU determines the monitor action to take based on the preconfigured option 'AND' or 'OR'. In case of 'AND' configuration, the transfer or shutdown action takes place only when both monitors signal alarm status at the same time, while either one of the MON units triggers the action in case of 'OR' configuration. For increased reliability, emergency terminator logic is included in the SCU, which shuts down the system if the voting logic is malfunctioning.

The LMI provides the system status and control using a combination of LCD and touchscreen panel. Touchscreen-based, graphic user interface software running on the LMI provides simple, easy-to-use and intuitive access to the system status and equipment control. The LMI also provides a message routing service for remote control and maintenance devices via a USB port and an Ethernet LAN port. With these interfaces, the operator can connect a PC running the PMDT software to view equipment status and alarm history, set up system parameters, and perform troubleshooting either at local or at remote.

The CSP consists of push buttons and light emitting diode (LED) indicators using which the system status and configuration can be displayed and modified.

The IFB provides surge protection (transient voltage suppression) and physical interfaces to various units such as LMI, EMU, remote voice, RCU and PMDT via RS-232, USB, modem (telephone line) and Ethernet.

The equipment is protected from any unexpected incoming high voltages by means of IFB. Digital input and output signals are photo coupled for galvanic insulation from outside. Also in case both TX1 and TX2 shutdown, the SCU is directed to block the +28V DC power being supplied to DUCU.

The EMU provides interface to various sensors such as smoke, temperature and intrusion sensor using which it monitors the environmental conditions that may affect continuous operation of the equipment. Also user-definable, analog and digital expansion input/output is provided. The EMU sends the information on the environmental conditions and the expansion I/O data to SCU via CAN bus.

1.8. PMDT SOFTWARE

1.8.1. GENERAL

Computer software for Portable Maintenance Data Terminal (PMDT) is provided. The PMDT consists of the PMDT software with a computer, a monitor display and a printer, etc. With the PMDT, the maintenance personnel are able to not only easily monitor and control the equipment but also diagnose, troubleshoot and calibrate the equipment. Each PMDT is designed to individually connect to the equipment to work on.

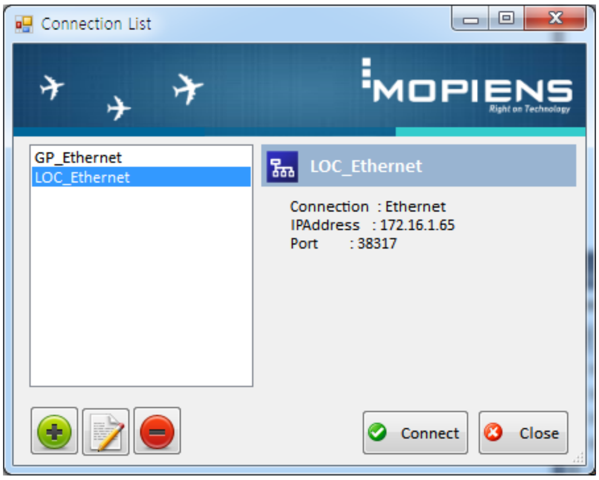

Figure 1-9. PMDT screenshot showing connection setup

The PMDT software is based on IBM PC compatible computers and Microsoft Windows operating system. It provides an intuitive and easy-to-use graphic user interface (GUI) for the maintenance of the navigation aids equipment. The PMDT can be connected to the equipment either locally or remotely over a suitable data link including UTP copper cable, fiber-optic and radio-link via TCP/IP Ethernet LAN port.

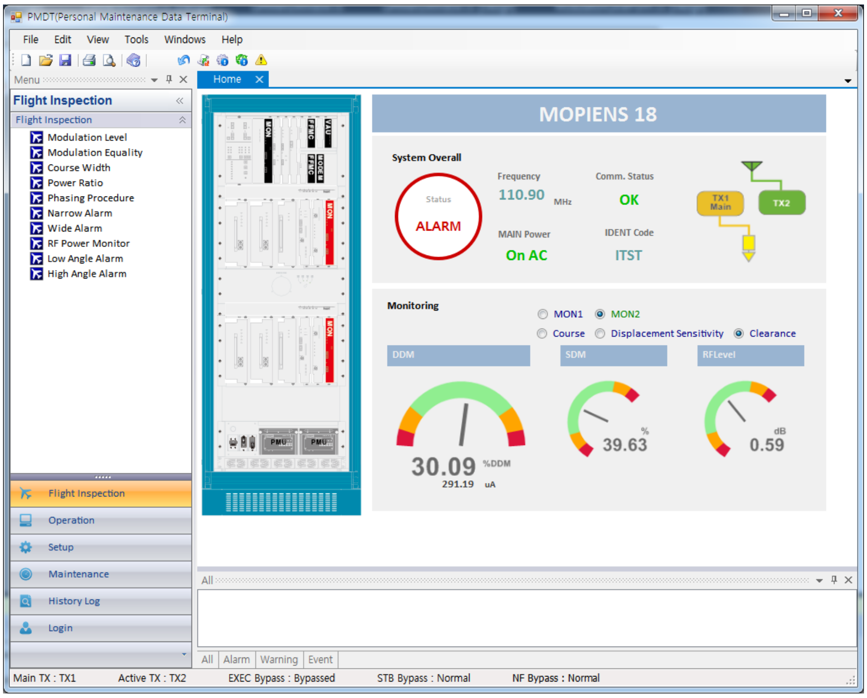

Figure 1-10. PMDT screenshot showing system status

1.8.2. FUNCTIONS

Functions that the PMDT provides include, but not limited to, the following:

- Selection of Main/Standby transmitter
- Transmitter On/Off
- Changeover between Main/Standby transmitters
- Bypass of Monitors for maintenance
- Control and adjustments of transmitter and power supply
- Control and adjustment of monitors
- Setup and configuration of system parameters
- Access to the Built-In Test Equipment (BITE) and identifying faulty units or antennas
- Readout and printout of system parameters at present
- Readout and printout of transmitter and monitor status
- Data logging of alarms, warnings, system parameter values, etc.
- Flight check/inspection and calibration support

With the PMDT, it is possible to control or adjust the standby transmitter, monitor or power supply while the main transmitter is in normal operation. The results of the maintenance works are recorded and saved into a file on the computer storage. The data logging is performed on real time basis. The size of the data logging is only limited by the capacity of the computer storage. The PMDT for LOC is also capable of logging the FFM and its power supply parameters.

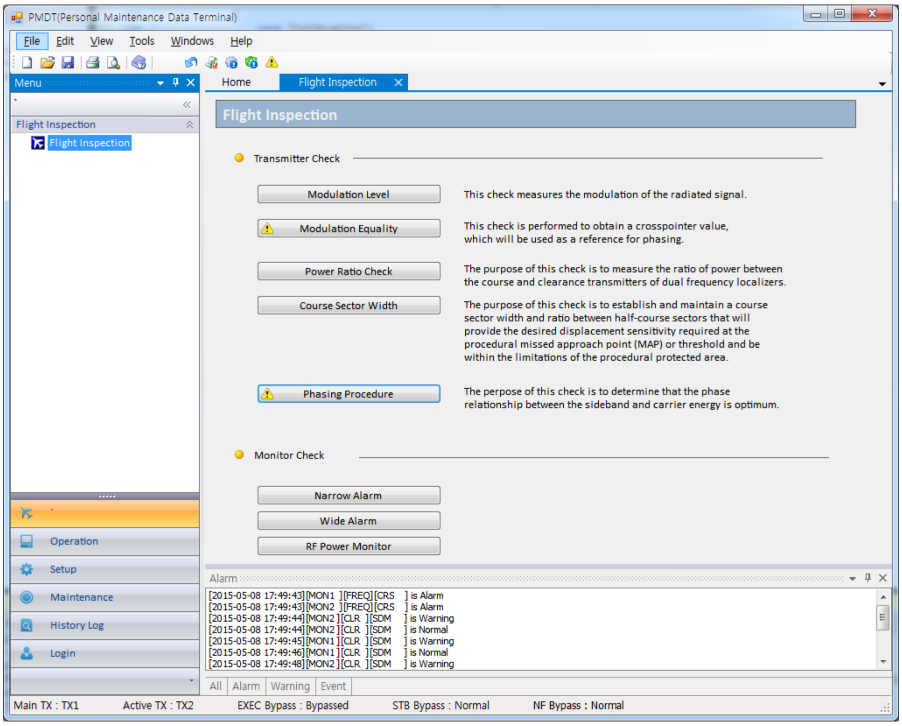

Figure 1-11. PDMT sceenshot showing flight check support menu

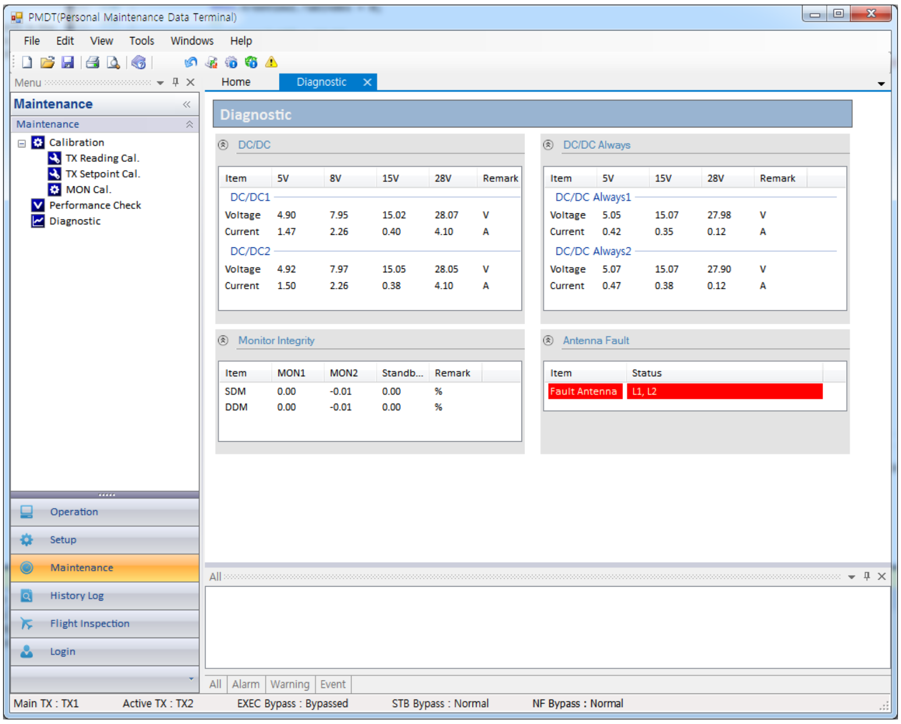

Figure 1-12. PMDT screenshot showing an antenna fault

1.8.3. SECURITY

The PMDT provides a log-on security to protect the system from an unauthorized access. By the access control, it is ensured that only the authorized personnel can get access to the equipment.

The built-in security system enforces the following policies by default:

- The user ID and password consist of up to 5 alpha-numeric characters.
- The access control list (ACL) which contains the IDs and passwords are kept in a protected storage area and updated on real-time basis when the administrator makes changes on it.
- Failed log-on attempts are recorded with its timestamp and relevant information and can be notified to the administrator.

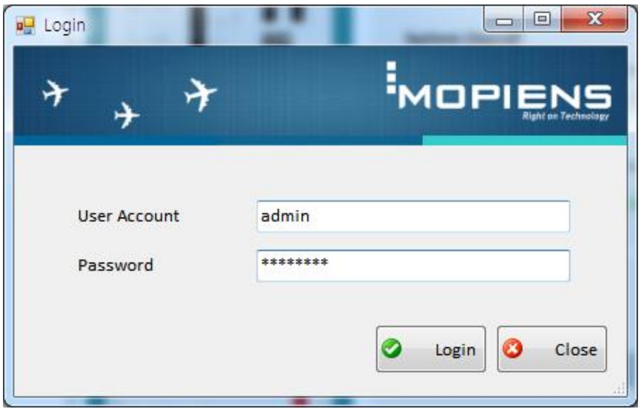

Figure 1-13. PMDT screenshot showing login

Security Level Classification

Level 1 - READ ONLY ACCESS

With this privilege level, the user is only able to READ-ONLY-ACCESS to the system. Readout of system status, configuration and monitor parameters are allowed, but no control that may change the system status is allowed.

Level 2 – READ-WRITE ACCESS

With this privilege level, the user is able to READ-WRITE-ACCESS to the system. Readout a of system status, configuration and monitor parameters and making change on the system configuration are allowed, except that it is not allowed to access the security ACL.

Level 3 – UNLIMITED ACCESS

With this privilege level, the user is able to perform unlimited access to the system including all the privilege that the level 2 has.

1.9. ANTENNA SYSTEM

1.9.1. GENERAL

The localizer signal produced by the transmitter equipment is radiated into the space by means of an antenna system. To ensure that the specified system performance is achieved, it is very important to select a proper site and also to have a proper antenna system installed.

Typically the localizer antenna system consists of an array of identical antenna elements. The type and number of elements of the antenna array should be carefully selected depending on the siting conditions.

1.9.2. ANTENNA OPTIONS FOR 510 LOC

For the single frequency 510 LOC, the following antenna system options are provided:

- 8-element Log Periodic Dipole Array (8-LPDA)
- 14-element Log Periodic Dipole Array (14-LPDA)
- Other types of antenna systems can also be provided upon request.

1.9.3. ANTENNA OPTIONS FOR 520 LOC

For the dual frequency 520 LOC, the following antenna system options are provided:

- 14-element Log Periodic Dipole Array (14/10-LPDA). The CRS signal is distributed all over the 14 elements while the CLR signal is only distributed to the 10 middle elements.
- 20-element Log Periodic Dipole Array (20/10-LPDA). The CRS signal is distributed all over the 20 elements while the CLR signal is only distributed to the 10 middle elements.
- Other types of antenna systems can also be provided upon request.

Figure 1-14. Typical 20/10-LPDA installaion

1.9.4. DISTRIBUTION UNIT / COMBINING UNIT

The radio frequency signal produced by the transmitter is distributed over the antenna array by the antenna distribution network (ADN). The amplitude and phase fed to each antenna element determine the overall localizer radiation pattern. Small portion of the radio frequency signal applied to each antenna element is sampled by a directional coupler built-into the antenna element. The entire sampled signal is then combined back in the monitor combining network (MCN) to produce a simulated receiver signal for monitoring the signal integrity.

Physically the ADN and MCN are housed in a single metal enclosure – distribution unit and combining unit (DUCU). The DUCU is normally installed at the center of antenna array for shortest possible cable run to each antenna element.

Figure 1-15. Distribution Unit / Comibining Unit, DUCU

1.9.5. SITING

Normally, the localizer antenna system is located on the extension on the center line of the runway at the stop end, and the equipment is adjusted so that the course line will be in a vertical plane containing the center line of the runway served. The antenna system should have the minimum height necessary to satisfy the coverage requirements, and the distance from the stop end of the runway should be consistent with safe obstruction clearance practice.

1.10. REMOTE CONTROL AND STATUS MONITORING

1.10.1. GENERAL

The 500 ILS system can provide indications at designated remote control points of the operational status of all ILS ground system components for Facility Performance Categories I, II and III requirements. For this purpose, the 600 Remote Control System is installed at the designated remote control points.

The 600 RCS provides visual indications, when systems are operating normally, when alarm conditions exist, and when communication faults exist. The remote control and status monitoring also provides the capability to transfer to standby equipment, if system is a dual equipment system, and to turn the system ON and OFF. The RCS is capable of displays and remote control of an ILS, VOR, DME, FFM, or a combination of all.

The 600 RCS can contain one or a combination of the following optional kits; the DME (single or dual) interface kit, Localizer / Glides Path (single or dual) interface kit, Marker Beacon (single or dual) interface kit, VOR (single or dual) interface kit, and FFM interface kit for facility performance category III localizer.

The 600 RCS consists of two distinct units: 610 Remote Control Unit, RCU and 620 Remote Status Unit, RSU.

1.10.2. REMOTE CONTROL UNIT

The 610 RCU contains an equipment cabinet assembly, a backplane, a power supply.

The RCU is generally located in the remote maintenance equipment room for monitoring and control of the navigational aids equipment.

The RCU has a built-in dedicated line modem and a generic RS-232C serial interface. Also it supports various types of remote access including UTP copper cable, fiber-optic and radio-link via TCP/IP Ethernet LAN port.

Figure 1-16. MOPIENS 610 Remote Control Unit

1.10.3. REMOTE STATUS UNIT

The 620 RSU processes information which is transformed into a visual indication of the operating status of the systems being monitored. The 620 RSU contains an equipment cabinet assembly, a backplane, a power supply.

The RSU is generally located in the control tower for monitoring of the ILS/VOR/DME and connected to the RCU via RS-485 link. Also it supports various types of remote access including fiber-optic and radio-link via TCP/IP Ethernet LAN port.

Figure 1-17. MOPIENS 620 Remote Status Unit

1.10.4. RCU / RSU WITH MULTI-FUNCTION DISPLAY (OPTIONAL)

The 610 RCU and 620 RSU provide Multi-Function Display with Touch Screen Color LCD.

It indicates current ILS status whether the system is either CAT I, CAT II, or CAT III

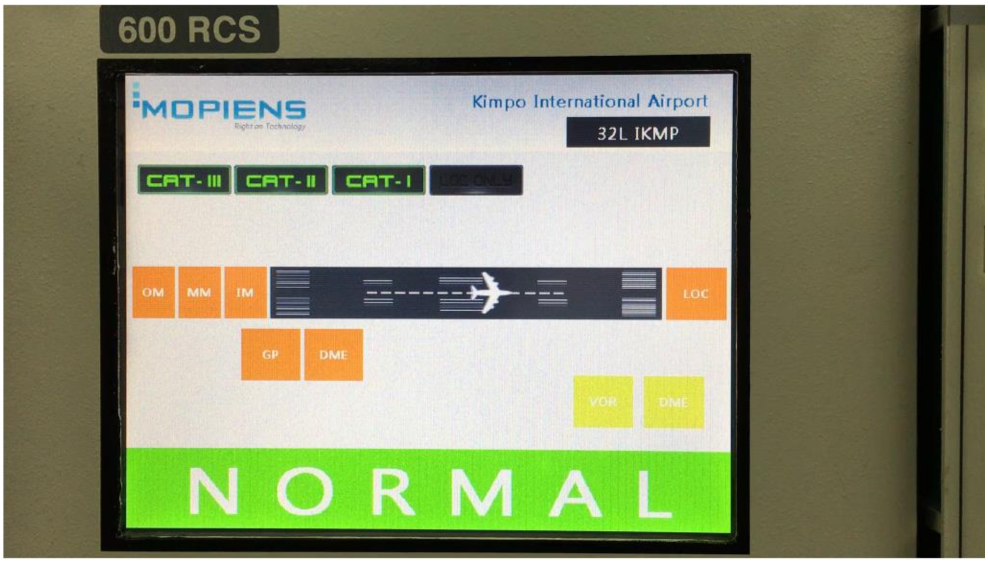

Figure 1-18. MOPIENS 610 RCU and 620 RSU Multi-Function Display

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2. TECHNICAL SPECIFICATIONS

2.1. APPLICABLE AND REFERENCE DOCUMENTS

Applicable and reference documents for the technical specifications of 510/520 LOC ILS are listed below.

- International Civil Aviation Organization (ICAO), International Standards and Recommended Practices, Aeronautical Telecommunications, Annex 10 to the Convention on International Civil Aviation, Radio Navigational Aids, Volume I, Sixth edition, July 2006
- International Civil Aviation Organization (ICAO), *Manual on Testing of Radio Navigation Aids*, *Testing of Ground-Based Radio Navigation Systems*, Doc. 8071, Volume 1, Fourth Edition, Amendment No.1, October 31, 2002
- United States Department of Transportation, Federal Aviation Administration (FAA), *Performance Specification Category I/II/III Instrument Landing System (ILS)*, FAA-E-2970, March 23, 2004

2.2. ENVIRONMENTAL SERVICE CONDITIONS

The 500 ILS environmental service conditions are listed below.

<u>For Indoor Equipment</u>

● Temperature	-10°C to +55°C
● Relative Humidity	up to 95% for temperature range -10°C to +35°C
	up to 60% for temperature range +35°C to +55°C
● Atmospheric Pressure	840 hectopascal

<u>For Outdoor Equipment</u>

● Temperature	-40°C to +70°C
● Relative Humidity	up to 95% for temperature range up to +35°C
	up to 60% for temperature range up to +70°C
● Wind Velocity	up to 45 m/sec, average,
	up to 62 m/sec, instantaneous maximum
● Icing	encased in 1.27 cm thick clear ice

2.3. PHYSICAL CHARACTERISTICS

● Housing	19” Standard rack cabinet
● Dimension	600mm (W) × 600mm (D) ×1,600mm (H)
● Weight	< 135 kg

2.3.1. EQUIPMENT VERSIONS

There are four versions of localizer available in the MOPIENS 500 ILS.

- 510 LOC – Single-frequency type, dual equipment version
- 520 LOC – Two-frequency (capture effect) type, dual equipment version
- 510S LOC – Single-frequency type, single-equipment version
- 520S LOC – Two-frequency (capture effect) type, dual equipment version

Single equipment versions and dual equipment versions differ as listed below.-

- Single Equipment: a standard single transmitter, single monitor, single or dual AC/DC power supply
- Dual Equipment: fully-redundant dual transmitters, dual monitors with separate standby monitor, dual power supply configuration. For CAT III operation hot-standby, a separate standby monitor (STBY MON) is available.

2.4. SYSTEM FEATURES

2.4.1. GENERAL

The localizer provides precision lateral guidance to an aircraft approaching or landing on a runway.

The radiation from the localizer antenna system produces a composite field pattern which is amplitude modulated by a 90 Hz and a 150 Hz tone. The radiation field pattern produces a course sector with one tone predominating on one side of the course and with the other tone predominating on the opposite side.

When an observer faces the localizer from the approach end of a runway, the depth of modulation of the radio frequency due to the 150 Hz tone predominates on his right hand and that due to the 90 Hz tone predominates on his left hand.

All horizontal angles employed in this manual specifying the localizer field patterns originate from the center of the localizer antenna system which provides the signals used in the front course sector.

2.4.2. COVERAGE

Coverage Sector

The 510/520 localizer provides signals sufficient to allow satisfactory operation of a typical aircraft installation within the localizer and glide path coverage sectors. Normally the course sector extends to outside ±35° from the course line in horizontal and beyond 7° in vertical.

Coverage Limits

The typical coverage sector of the properly installed 510/520 localizer with suitable antenna system extends from the center of the localizer antenna system to distance of:

- 25 NM within ±10° from the front course line;
- 17 NM between 10° and 35° from the front course line;
- 10 NM outside of ±35° from the course line

The localizer signals are receivable at the distance specified and above a height of 600 meters above the elevation of the threshold, or 300 meters above the elevation of the highest point within the intermediate and final approach areas, whichever is higher. Such signals are receivable to the distances specified, up to surface extending outward from the localizer antenna and inclined at 7° above the horizontal.

Field Strength

The signal strength in coverage volume is greater than or equal to 40 µV/m (= -114 dBW/m^2) at the output power level which is reduced to trigger the output power level alarm threshold.

When properly installed in combination with a suitable antenna system and relevant siting criteria are met, the minimum field strength on the ILS glide path and within the localizer course sector is greater than 100 µV/m (= -106 dBW/m^2) at a distance of 10 NM, increasing to at least 200 µV/m (= -100 dBW/m^2) at 6 meters above the horizontal plane containing the threshold. From this point to a further 4 meters above the runway center line, and 300 meters from the threshold in the direction of the localizer, and thereafter at a height of 4 meters along the length of the runway in the direction of the localizer, the field strength is greater than 100 µV/m (= -106 dBW/m^2). These characteristics meet or exceed the requirements for the Facility Performance Category I, II and III localizers.

With proper installation and adjustment of the antenna system, the signals are reduced to as low as practicable above 7°.

Course / Clearance Ratio

With a properly installed 520 two-frequency localizer, the ratio of the two carrier signal strengths - course signal strength to clearance signal strength - in space within the front course sector extended to the coverage limit is greater than or equal to 10 dB and can be further adjusted to exceed 16 dB fulfilling the requirements for the Facility Performance Category III localizers.

2.4.3. COURSE CHARACTERISTICS

Course Structure

With 510/520 localizer combined with a suitable antenna system properly installed at a location meeting relevant siting criteria, bends in the course line does not have amplitudes which exceed the following:

Zone	Amplitude (DDM) (95% probability)
Outer limit of coverage to ILS Point “A”	0.031
ILS Point “A” to ILS Point “B”	0.031 at ILS Point “A” decreasing at a linear rate to 0.005 at ILS Point “B”
ILS Point “B” to the ILS reference datum	0.005

and, for Category III only:

ILS reference datum to ILS Point “D”	0.005
ILS Point “D” to ILS Point “E”	0.005 at ILS Point “D” increasing at a linear rate to 0.010 at ILS Point “E”

The amplitude referred to the above are the DDMs due to bends as realized on the mean course line, when correctly adjusted.

Course Alignment Accuracy

With 510/520 localizer combined with a suitable antenna system properly installed at a location meeting relevant siting criteria, the mean course line can be adjusted and maintained within limits equivalent to the displacement of ±3 meters from the runway center line at the ILS reference datum. This corresponds to the requirements for Facility Performance Category III localizers, exceeding the requirements for Facility Performance Category I and II localizers.

Displacement Sensitivity

The nominal displacement sensitivity within the half course sector at the ILS reference datum is typically 0.00145 DDM/m except that for Category I localizers, where the specified nominal displacement sensitivity cannot be met, the displacement sensitivity is adjusted as near as possible to that value. According to the ICAO Annex 10, for Facility Performance Category I localizers on runway codes 1 and 2, the nominal displacement sensitivity should be achieved at the ILS Point "B".

Course Sector Width

The displacement sensitivity of 0.00145 DDM/m corresponds to a course sector width of 210 meters with reference to the DDM of ±0.155 at ILS reference datum. According to the paragraph 3.1.3.7, ICAO Annex 10, the maximum course sector angle should not exceed 6°. Actual course sector angle can be easily adjusted by setting the SBO output level at a proper point. With the 510/520 localizer in combination with suitable antenna system properly installed at a location meeting relevant siting criteria, a typical adjustable range of the course sector width is between 2.2° and 7.5°.

With 510/520 localizer combined with a suitable antenna system properly installed at a location meeting relevant siting criteria, the lateral displacement sensitivity can be adjusted and maintained within the limits of ±10%, which exceed the requirement for Facility Performance Categories I and II and meets the requirements for Facility Performance Category III.

The increase of DDM is substantially linear with respect to angular displacement from the course line (where DDM is zero) up to an angle on either side of the front course line where the DDM is 0.180. From that angle to ±10°, the DDM is greater than 0.180. From ±10° to ±35°, the DDM is greater than 0.155. Where coverage is required outside of the ±35° sector, the DDM in the area of the coverage, except in the back course sector, is greater than 0.155.

2.4.4. RADIO FREQUENCY

The 510/520 localizer transmitter is capable of operation in 0.05 MHz increments across the band of 108 to 111.975 MHz. The frequency tolerance does not exceed ± 0.001 percent over the service conditions, which marginally exceeds the requirements of ICAO Annex 10.

With the two-frequency, 520 LOC, the nominal band occupied by the carriers is symmetrical about the assigned frequency. Also, the course transmitter frequency is adjustable and the clearance frequency is locked to the course transmitter frequency. The RF frequency separation between the carriers is 8 kHz nominal but adjustable in the range 5 kHz to 14 kHz.

Polarization

- The emission from a 510/520 localizer with a suitable antenna system properly installed is horizontally polarized. The vertically polarized component of the radiation within a sector bounded by 0.02 DDM either side of the course line is less than that which corresponds to a DDM error of 0.005 when an aircraft is positioned on the course line and is in a roll attitude of 20° from the horizontal.

When relevant siting criteria are met and suitable antenna system is used in combination with the

520 localizer, signals emanating from the transmitter contain no components which result in an apparent course line fluctuation of more than 0.005 DDM peak to peak in the frequency band 0.01 Hz to 10 Hz, which exceeds the requirements for the Facility Performance Category I and meets the requirements for the Facility Performance Category III localizers.

2.5. TRANSMITTER

The transmitter consists of a modulation signal (AF) generator including identification signal keyer, a carrier signal (RF) generator/ synthesizer, a modulator and a power amplifier.

2.5.1. OUTPUT POWER

The localizer carrier output power is adjustable over the range of 25% to 100% of the rated transmitter output power.

● CSB Output Power	Adjustable	5 to 25 W by software in 0.1W step
● SBO Output Power	Adjustable	0 to 1.5 W by software

Adjustment over this range in the entire service conditions does not change the modulation balance by more than 0.002 DDM, the course width by more than 2.0%, the percentage of identification modulation by more than 10% of normal, the carrier modulation by more than ± 1.0%, and the sideband phasing by more than ±5°.

Clearance Power Control

For the two-frequency, 520 LOC, output power of both course and clearance channel can be individually adjusted while meeting the specifications above.

Sideband Suppression

- After proper adjustments, for any combination of sideband amplitude control or its phase control settings, the carrier power appearing at the carrier output is 30 dB below the carrier power appearing at the carrier output when measured over the entire service conditions.

2.5.2. TRANSMITTER STABILITY

After initial adjustment under normal test conditions for optimum transmitter performance, changes over the service conditions do not exceed the limits listed below.

● Carrier Output Power	± 10%
● Sideband ratio	± 0.5 dB
● Carrier modulation	± 1 % for each tone
● Carrier modulation balance	± 0.005 DDM
● Sideband balance	± 0.3 dB
● RF phase between carrier and sideband output	± 10°
● 90 Hz / 150 Hz tone frequency	± 0.01%
● Transmitter frequency	± 0.002%
● Identification tone frequency	± 0.01%

In the case of two-frequency localizer, both course and clearance transmitters meet the specification above.

2.5.3. FREQUENCY CONTROL

The transmitter frequency is controlled by a phase locked loop (PLL) frequency synthesizer. The reference frequency for the PLL is controlled by direct digital synthesis (DDS) technology. The main reference clock is generated by a precision temperature-controlled crystal oscillator (TCXO).

The frequency of the localizer station can be set to one of the channel frequencies in the band 108 MHz to 111.975 MHz in 50 kHz spacing. No special modification or tuning is needed for the frequency adjustment.

The transmitter frequency and the carrier separation in two-frequency system are adjustable in the range of 5 kHz to 14 kHz and programmed by software. Both course and clearance transmitter frequencies are derived from the common precision reference clock source and automatically set to the correct offset frequencies based on the station frequency.

2.5.4. RF PHASE CONTROL

The sideband phase with reference to the carrier phase is adjustable over the range of ± 180° in steps of 1° by means of software. The amplitude of the output signal does not vary more than ± 0.25 dB by this control in its entire range.

2.5.5. MODULATION

The nominal depth of modulation of the radio frequency carrier due to each of the 90 Hz and 150 Hz tones is 20% along the course line. The depth of modulation of the radio frequency carrier due to each of the 90 Hz and 150 Hz tones can be maintained within the limits of 18% and 22%. The modulation tone frequencies of the radio frequency carrier are 90 Hz and 150 Hz within ± 0.01% over the service conditions, where the tolerance exceeds the requirements for Facility Performance Categories I, II and III ILS localizers.

<u>Modulation Control</u>

A control is provided to adjust the modulation depth of the transmitter as listed below:

- SDM 0% to 50% in 0.1% step; adjustable by software
- DDM 0 to actual SDM setting in 0.1% step
- Adjustment of this control over its entire range does not produce a change of more than ± 5° in RF phase between carrier sideband outputs, measured over the full range of service conditions.

<u>Modulation Balance</u>

By above control, each of the 90 Hz and 150 Hz modulation depth is adjusted from 0% to 25% in 0.1% step and the modulation balance can be precisely adjusted in the range of ±25% in 0.1% step. Either the 90 Hz tone or the 150 Hz tone can be independently suppressed by the control. Simultaneous removal of the both modulation components is also possible.

<u>Distortion</u>

The total harmonic contents (THD) of the 90 Hz tone are less than 1% and the second harmonic of the 90 Hz tone is less than 0.5%. The total harmonic contents of the 150 Hz tone are less than 1%.

The depth of amplitude modulation of the radio frequency carrier at the power supply frequency or its harmonics, or by other unwanted components is less than 0.5%. Harmonics of the supply, or other unwanted noise components that may inter-modulate with the 90 Hz and 150 Hz navigation tones or their harmonics to produce fluctuations in the course line is less than 0.05% modulation depth of the radio frequency carrier.

Undesired frequency and phase modulation on the ILS localizer frequency carriers that can affect the displayed DDM values in localizer receivers are minimized.

Relative Phase of Modulation Tones

The relative phase of the 90 Hz and 150 Hz modulation tones of the course transmitter is phase-locked such that the demodulated 90 Hz and 150 Hz waveforms pass through zero in the same direction within ± 5° of phase relative to the 150 Hz component every half cycle of the combined 90 Hz and 150 Hz waveform.

Clearance Modulation

For the two-frequency, 520 LOC, modulation of both course and clearance channel can be individually adjusted while meeting the specifications above. Also, each carrier meets the conditions stated above and the 90 Hz modulating tone of one carrier is phase-locked to the 90 Hz modulating tone of the other carrier so that the demodulated waveforms pass through zero in the same direction within 5° of phase relative to 150 Hz.

2.5.6. IDENTIFICATION

The primary identification of the 510/520 localizer is provided by the simultaneous transmission of an identification signal, specific to the runway and approach direction, on the same radio frequency carrier or carriers as used for the localizer function. The transmission of the identification signal does not interfere in any way with the basic localizer function.

- Emission type designation — A2A, keying a tone modulated onto a carrier
- Carrier emission polarization — Horizontal
- Tone Frequency — 1020 Hz ± 0.01%
- AM Depth — 0 to 15% in 0.1% step; adjustable by software

According to the ICAO Annex 10, where a radiotelephone communication channel is provided, the depth of modulation should be adjusted so that the ratio of peak modulation depth due to radio telephone communications to that due to the identification signal modulation is approximately 9:1. The emission carrying the identification signal is horizontally polarized as the identification is on the same carrier as the navigation components.

The identification signal consists of up to 4 letters of the ITU standard, international Morse code. The time duration of dot is 125 milliseconds and a dash is 3 times the duration of the dots, 375 milliseconds. The duration between dots and dashes is equal to that of one dot ±10%. The time duration between letters or numerals is not less than three dots. The transmission of the identification is at a rate approximately 7 words per minute (WPM) and repeated at least once every 40 seconds or at a preset interval.

The emission of identification code is suppressed when transmission of the normal localizer signal is not available for operational use due to removal of navigational components or maintenance or test.

For the two-frequency, 520 LOC, the relative phase of the identification signal modulations, is such as to avoid the occurrence of nulls within the coverage of the localizer.

Identification Keying

The keying circuitry for the identification signal is completely electronic by using a solid-state switch and modulates the carrier with a 1020 Hz tone without interruption of the carrier.

The transmission of the identification can be operated in one of the following modes:

- Independent mode – The localizer independently transmits its own identification code.
- Associated mode – Transmission of the identification is associated with collocated equipment
- Test mode – The 1020 Hz tone is not keyed but continuously transmitted for test purpose.
- Off – The transmission of identification code is removed.

In the “associated” mode, the keying is operated as follows:

- The transmission of the identification is synchronized with the associated equipment, such as DME.
- Each interval of the repetition period is divided into four or more equal periods, with the associated equipment identification transmitted one period and the localizer identification transmitted during the remaining periods.
- One of the associated equipment become “master” and the other becomes “slave” in keying the identification code. The master provides keying for the slave. The 510/520 LOC can be configured either as “master” or “slave”.
- If the 510/520 LOC is configured as “slave” but no keying is available from the “master” for a preset period of time, the keying can be reverted to the Independent mode.

The 510/520 LOC provides keying interface to the associated “slave” and the interface is galvanically-isolated for protection against transient voltage.

2.5.7. VOICE

For Facility Performance Categories I and II localizers, a ground-to-air communication channel to be operated simultaneously with the navigation and identification signals is optionally provided. The operation of the voice channel can be adjusted to not interfere in any way with the basic localizer function.

The voice channel is on the same radio frequency carrier or carriers as used for the localizer function and the radiation is horizontally polarized. Where two carriers are modulated with speech, the relative phases of the modulations on the two carriers are such as to avoid occurrence of nulls within the coverage of the localizer.

The peak modulation depth of the carrier or carriers due to the radiotelephone communications does not exceed the 50% limit and can be adjusted so that the ratio of peak modulation depth due to the radiotelephone communications to the identification signal is approximately 9:1 and the sum of modulations components due to use of the radiotelephone channel, navigational signals and identification signals does not exceed 95% as required by ICAO Annex 10.

- AM Depth: 0 to 40% in 0.1% step; adjustable by software
- Frequency Response: < 1 dB relative to the level at 1000 Hz over the range 300Hz to 3000Hz;
- Out-of-band attenuation: > 12 dB/octave
- Interface: 600 Ω balanced, -37 dBm to +5 dBm adjustable
- Speech processor: < 1dB change in output for 15dB change in input

● Total Harmonic Distortion	< 3% at 30% AM

2.5.8. TRANSMITTER CONTROL

The transmitter can be controlled by either local or remote but only one side at a time can seize the control over the system. The selection of local control or remote control is switched by the key lock switch on the LMI. The actual execution of transmitter control is carried out by the System Controller Unit, SCU.

For the two-frequency system, the clearance transmitter control can be linked to the course transmitter, so that it can be automatically turned on or off depending on the course transmitter's power on/off status, or can be independently controlled by the SCU on the command from the local or remote control.

2.6. MONITORING SYSTEM

2.6.1. GENERAL

The 510/520 LOC is provided with a high integrity monitor system. It provides fault detection and warning by monitoring the predefined signal parameters and initiates automatic shutdown or changeover of the transmitters, when the radiated signals persists to deviate beyond predefined conditions.

For the 510/520 dual-equipment localizer, dual redundant monitors in parallel configuration are provided. A single monitor is provided with a 510S/520S single-equipment localizer by default. A second monitor can be incorporated to the 510S/520S LOC as an option for dual, redundant parallel monitoring.

The two monitors are in alarm status before a changeover or shutdown is initiated, unless the transfer is manually initiated or one monitor is removed from service.

An additional monitor is optionally provided for the hot standby monitoring of the Facility Performance Category III localizers. The hot standby monitor is identical to the two regular monitors and dedicated to monitoring of the standby transmitter.

For the 520 dual-frequency localizer, each course and clearance transmitter radiated parameter is examined by two identical monitor channels.

The monitor can be bypassed for maintenance purpose so as to prevent initiating a changeover or shutdown in alarm conditions. Dedicated switches and controls for bypassing the monitor are provided on the local and remote control points. Relevant indication of monitor bypass status is simultaneously provided on the local and remote status monitoring points. The monitor system continues providing warnings and alarms while bypassed.

Executive monitor functions are primarily carried out by an integral monitor system. Optional near field monitoring and far field monitoring are also provided. The optional near field monitoring and far field monitoring can be configured to be executive or non-executive.

Features

● Dual Monitor Operation	AND / OR
● Alarm Settings	Severities and limits programmable by software
● Pre-alarm conditions	Programmable warning
● Failsafe Operation	Supported

- Radiation of false signal — < 1 second for dual transmitter

2.6.2. MONITOR PARAMETERS

Channels

● Integral Monitor Channels	Course Line, Displacement Sensitivity, Clearance Width (dual frequency only)
● Field Monitor Channels	(Optional) Near Field, Far Field
● Standby Monitor Channels	Course Line, Displacement Sensitivity, Clearance Width

Parameter Readings

● DDM	0 to ±0.500 DDM in 0.001 resolution
● SDM	0 to 50% in 0.1% resolution
● RF Level	-50 dBm to 0 dBm in 0.1 dB resolution
● IDENT Modulation	0 to 30% in 0.1% resolution

Processing Interval

● SDM, DDM, RF level	< 0.5 sec
● Output power, VSWR	< 2.5 sec
● RF Frequency	< 5 sec;
● IDENT Modulation and Integrity	< 30 sec;

2.6.3. MONITOR STABILITY

All monitor channels become stable within 0.5 seconds after initial application of radiated signals. The monitor system begins to take an executive monitor action within 0.5 seconds after initial application of the radiated signals when such signals are outside of allowable tolerances. Interaction of all the monitor parameters is minimized allowing simple straightforward adjustments of all monitor parameters in turn with minimum readjustment.

Stability at Nominal Input Levels

● Course DDM	±0.003 DDM
● Width DDM	±0.015 at 0.200 DDM
● SDM	±0.5% at 40% SDM
● IDENT modulation	±1% at 5 % modulation
● RF Level	±0.2 dB or ±10% whichever lower

2.6.4. FAULT CONDITIONS

The conditions that cause the system to initiate of monitor action vary depending on the installation and configuration setup. The following basic conditions are required by ICAO Annex 10 and can be implemented with 510/520 LOC with suitable antenna system properly installed and adjusted.

- For Facility Performance Category I, a shift of the mean course line from the runway center line equivalent to more than 10.5 meters or the linear equivalent to 0.015 DDM, whichever less, at the ILS reference datum.
- For Facility Performance Category II, a shift of the mean course line from the runway center line equivalent to more than 7.5 meters at the ILS reference datum.
- For Facility Performance Category III, a shift of the mean course line from the runway center line equivalent to more than 6 meters at the reference datum.
- In the case of the single-frequency localizer, a reduction of power output to less than 50% of normal, provided that all other performance specifications are met.
- In the case of the two-frequency localizer, a reduction of power output for either carrier to less than 80% of normal, except that a greater reduction between 80% and 50% of normal may be permitted, provided the localizer continues to meet all other performance specifications are met.
- Change of displacement sensitivity to a value differing by more than 17% from the normal value for the localizer facility.
- In the case of the two-frequency localizer, the DDM in the required coverage beyond ±10° from the front course line, except in the back course sector, decreases below 0.155.

Besides the condition listed above, the following conditions can be implemented with 510/520 localizer:

- A change of the 90 Hz and 150 Hz modulation outside the 18% to 22% or the pre-configured limits.
- Identification tone continuously presents more than 17 seconds or the pre-configured period.
- Reduction of identification modulation; the threshold is adjustable over the range of 2.5% to 12% or the pre-configured limits.
- For two-frequency localizers, a change in the frequency separation of the course and clearance transmitters more than ±1 kHz or pre-configured limits.
- An open or short fault at any antenna element, feeder or monitor line, or RF distribution network.
- Mechanical misalignment of any radiating element of the antenna array.

The total period of radiation, including period(s) of zero radiation, outside the performance limits specified above does not exceed under any circumstances:

- 10 seconds for properly installed and configured for Category I localizers;
- 2 seconds for properly installed and configured for Category II localizers;
- 1 second for properly installed and configured for Category III localizers.

Any erroneous navigation signals on the carrier during removal of navigation and identification components are suppressed within the total period above.

2.6.5. MONITOR ACTION

If a fault is detected by both monitors and persists for a preset period of time or longer, the monitor initiates the following actions:

- Cause radiation of the localizer to cease
- Cause the localizer transmitter to transfer to the standby transmitter and activate it.

- If the fault persists for the balance of the preset period of time following transfer, the localizer shutdown and prevent restoration for at least 20 seconds.
- Following changeover or shutdown, initiate a local visual/aural alarm and transmit the alarm indications to the remote control point.

Monitor Action Delay

For the fault conditions, the monitor has a hold-off period adjustable from 0.3 seconds to 10 seconds during which time shutdown or transfer control is inhibited.

Switch Over Time

- For hot standby transmitter ≤ 20 milliseconds
- For cold standby transmitter ≤ 6 seconds

2.6.6. MONITOR FAIL-SAFE

The monitor system is designed to remove the navigation guidance and identification and to provide a warning to the designated remote control points in the event of failure of the monitor system itself. The failure of any part of the monitor either results directly in an alarm condition or does not alter any alarm threshold level in a way to allow an out-of-tolerance condition to occur without detection.

The Monitor itself is checked for signal integrity by automatic self-test. A degenerated course line baseband is multiplexed into separate self-test channels. These signals are sampled and checked for integrity in the same way as the normal baseband signals. The test channels toggle between normal signal values and degenerated signal values and thus the status toggles between normal and alarm state. If the monitor is unable to detect degenerate signals and raise an alarm state the monitor itself is put in an alarm state.

Depending upon the operating state of the other monitor, further action for either system warning or changeover/shutdown may be initiated.

2.7. LOCAL CONTROL AND STATUS DISPLAY

2.7.1. CSP

The Control Status Panel, CSP provides simple and straightforward status indication and control of the equipment using the LED indicators and mechanical push button switches incorporated in an intuitive layout. It is based on pure hardware logic without any microprocessor or software for better stability and reliability.

2.7.2. LMI

The Local Maintenance Interface, LMI provides more sophisticated control and status display. It is based on an industrial embedded computer with a TFT color LCD screen and touchscreen interface. All the controls and status indications that are possible with the CSP are also possible with the LMI. In addition, the monitor parameter readings and the detailed equipment status can be displayed on the LMI.

2.7.3. UNIT FRONT FACE

Each individual unit also provides basic status display of its own through a number of LED indicators on the front of the unit. The status display includes power on and fault condition in general and some others specific to each unit. Those units which include a microprocessor controller also provide a pushbutton switch to reset the processor and initialize the firmware running on it.

2.8. POWER SUPPLY

● AC Input Voltage	95 to 265 V, 47 Hz to 63 Hz
● DC Input Voltage	28 V nominal, 22 to 32V

2.8.1. POWER CONSUMPTION

● AC Input	less than 700 VA
	(Hot standby excluding battery charging current)
● DC Input	less than 480 W
	(Hot standby)

2.8.2. BACKUP BATTERY

● Action on power interruption	“No-break” - continuous operation
● Backup capacity	4 hours of continuous operation

- in full hot-standby mode

2.9. INTEGRITY AND CONTINUITY OF SERVICE

2.9.1. INTEGRITY

The probability of not radiating false guidance signals is greater than $1 - 0.5 \times 10^{-9}$ in any one landing, which exceeds the requirements for Facility Performance Category I localizers and complies with the requirements for Facility Performance Categories II and III localizers.

2.9.2. CONTINUITY OF SERVICE

The probability of not losing the radiated guidance signal is greater than $1 - 2 \times 10^{-6}$ in any period of 30 seconds, which exceeds the requirements for Facility Performance Categories I, II or localizers intended to be used for Category III A and complies with the requirements for Facility Performance Categories III localizers intended to be used for the full range of Category III operations (equivalent to 4,000 hours of mean time between outages).

2.9.3. RELIABILITY

● Mean time between Failures	longer than 6,000 hours
	(Single equipment configuration, MIL-STD-217F)
● Mean time between Outages	longer than 15,000 hours
	(Dual equipment configuration)

3. TECHNICAL DESCRIPTION

3.1. SYSTEM DESCRIPTION

A simplified block diagram of 510/520 localizer is shown in Figure 1-2.

A RF carrier, amplitude modulated with 90 Hz and 150 Hz CSB and a suppressed-carrier SBO signal are generated by the transmitter. The synthesizer (SYN) generates the RF carrier in the range 108 MHz to 112 MHz in 50 kHz increments, providing 40 channels. Only one channel with the 50 kHz bandwidth is assigned to a station. With the use of a TCXO combined with DDS technology, the synthesizer provides a very accurate signal. The synthesizer generates the RF carrier for the course LMA and clearance LMA (for dual equipment).

The modulation signal generator (MSG) generates the 90 Hz + 150 Hz audio for the composite carrier-plus-sideband (CSB) and 90 Hz – 150 Hz audio for the sideband-only (SBO) by means of a direct digital synthesis (DDS) technology.

The LMA takes the RF carrier signal from the synthesizer (SYN) as input and produces the modulated and amplified CSB signal and SBO signal as output by amplitude modulating the RF carrier signal with the 150 Hz + 90 Hz and 150 Hz – 90 Hz audio signals from the MSG. Thanks to the sophisticated Cartesian feedback loop control incorporated in the LMA, high power output signals with accurate waveforms and coherent phase relationship are produced in high efficiency.

With the 520, two-frequency localizer, outputs from the two transmitters are changed over in double pole double throw (DPDT) manner so that the output of the main transmitter is fed to the antenna system and the output of the standby transmitter is fed to the dummy load.

The signals fed into the antenna system are radiated into the air and the SBO signals are recombined with the CSB in space thus producing a variation in difference in depth of modulation (DDM) between the 90 Hz and 150 Hz signals.

The automatic monitor system provides a warning to the designated control points and cause radiation to cease within preset period if the integrity of the signals is degraded beyond acceptable tolerance limits.

The monitor (MON) units take measurements of the radiated signal by actually picking up signals in the field or by recombining signals sampled from each antenna. A digital signal processing (DSP) technique is incorporated in the monitor unit for the sake of accurate and reliable signal integrity assessment.

In case two monitor units are equipped, a voting circuitry is used to determine the action to take. Both ‘AND’ mode and ‘OR’ mode are supported in the voting logic. When the ‘AND’ mode is in effect, an executive action is taken only if the two monitors gives the same result on the signal integrity analysis. If the two monitors do not agree on it, no action is taken. When ‘OR’ mode is in effect, an executive monitor action is taken if either one of the monitors detects an executive alarm condition.

3.1.1. OVERVIEW

The 510/520 LOC equipment cabinet is composed of the following subracks as shown in Figure 1-4 and Figure 1-5.

- Auxiliary electronics subrack, 1A1
- Fan shelf, 1A2A7

- Transmitter/monitor subrack, 1A2
- Fan shelf, 1A3A7
- Transmitter/monitor subrack, 1A3
- Power monitoring unit subrack with switches/indicators panel, 1A4
- AC/DC converter subrack, 1A5

3.1.2. AUXILIARY ELECTRONICS SUBRACK

The Auxiliary electronics subrack, 1A1, contains the following LRUs:

- Control Status Panel, CSP, 1A1A1
- Standby Monitor Unit, MON, 1A1A2
- System Controller Unit, SCU, 1A1A3/1A1A4
- Environmental Monitor Unit, EMU, 1A1A5Far Field Monitor Controller, FFMC, 1A1A6/1A1A7
- DC/DC Converter for Auxiliary 1A1A8/1A1A9
- Modem, 1A1A10/1A1A11
- Voice Amplifier Unit, VAU, 1A1A12
- Interface board, IFB, 1A1A13
- BP-A, 1A1A14

3.1.3. FAN SHELF

The fan shelf consists of four highly reliable and efficient cooling fans.

- Cooling fan for TX1, 1A2A7
- Cooling fan for TX2, 1A3A7

Fan On/off control is provided by each TX controller (MSG).

3.1.4. TRANSMITTER/MONITOR SUBRACK

The Transmitter/Monitor subrack consists of the following LRU's.

Single-Frequency LOC

- Localizer Modulation Amplifier, LMA, 1A2A1/1A3A1
- DC-to-DC converter, DC/DC, 1A2A3/1A3A3
- Modulation Signal Generator, MSG, 1A2A4/1A3A4
- Synthesizer, SYN, 1A2A5/1A3A5
- Monitor, MON, 1A2A6/1A3A6

Two-frequency LOC

- Localizer Modulation Amplifier for Course, (CRS) LMA, 1A2A1/1A3A1
- Localizer Modulation Amplifier for Clearance, (CLR) LMA , 1A2A2/1A3A2

- DC-to-DC converter, DC/DC, 1A2A3/1A3A3
- Modulation Signal Generator, MSG, 1A2A4/1A3A4
- Synthesizer, SYN, 1A2A5/1A3A5
- Monitor, MON, 1A2A6/1A3A6

3.1.5. POWER MONITOR UNIT SUBRACK

The Power Monitoring Unit subrack consists of PMU LRU:

- Power Monitoring Unit, 1A4A1/1A4A2

3.1.6. AC/DC CONVERTER SUBRACK

Up to 5 AC to DC converter units which provide 28VDC, 1500W each, (scalable) are available. The AC/DC units used for ILS equipment are readily available Commercial-off-the-shelf (COTS) units placed at the bottom shelf of the equipment below the power On/Off switch and PMUs.

3.2. UNIT DESCRIPTION

3.2.1. LMA, 0432-7140

The LMA modulates the radio frequency carrier signal with the audio frequency modulation signal and amplifies the modulated radio frequency signal to get the required power output. The same LMA can be used for the course transmitter or for the clearance transmitter without any modification or adjustment and without any settings.

A LMA consists of CSB modulation amplifier and SBO modulation amplifier. Each modulation amplifier is a type of Cartesian-feedback amplifier. The CSB and SBO are driven by a common RF carrier signal, hence maintains stable phase-coherence in all service conditions. A simplified block diagram of LMA is shown in Figure 3-1.

The Cartesian-feedback amplifier is composed of a complex (I/Q) modulator, an RF amplifier, a complex (I/Q) demodulator, and an error amplifier.

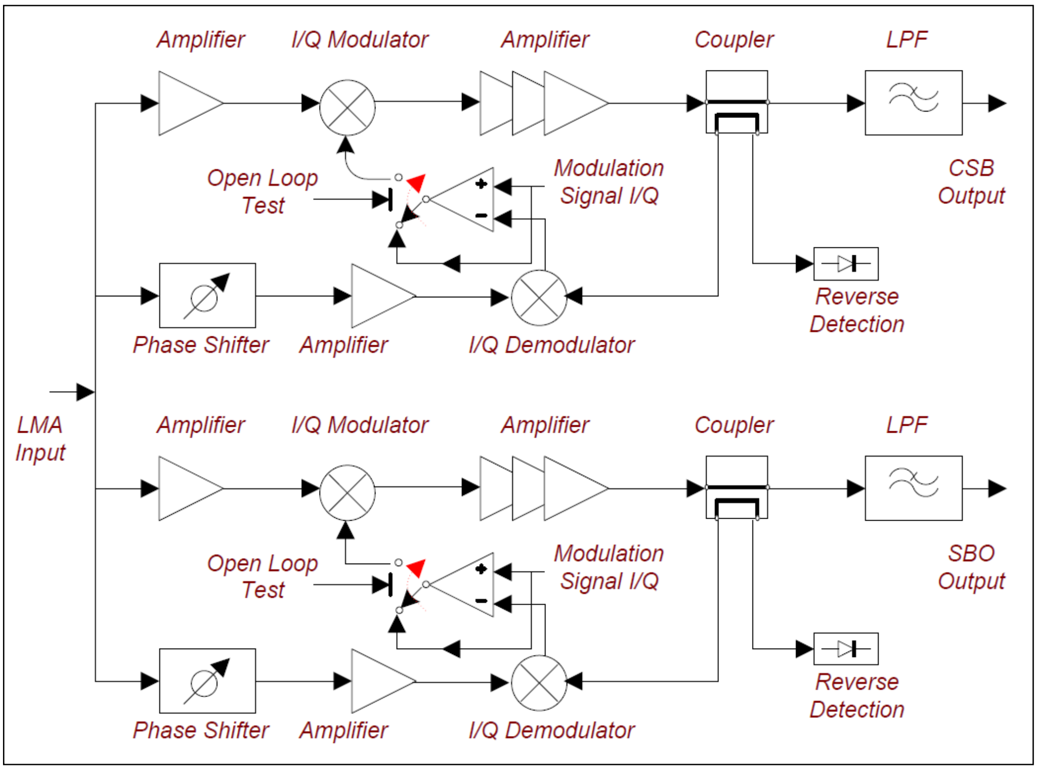

Figure 3-1. LMA Block Diagram

The carrier signal which is generated by the frequency synthesizer is amplitude-modulated, phase-compensated, and phase offset adjusted in the modulator.

The modulation signal for the carrier consists of 90 Hz / 150 Hz sinusoidal signal for phase reference, on/off-keyed 1020 Hz sinusoidal signal for station identification, and optional voice signal. The composite modulation signal is generated in the modulation signal generator (MSG).

The amplitude modulated signal is then filtered and amplified to the necessary level to drive the power amplifier. Figure 3-2 shows the detailed block diagram of LMA.

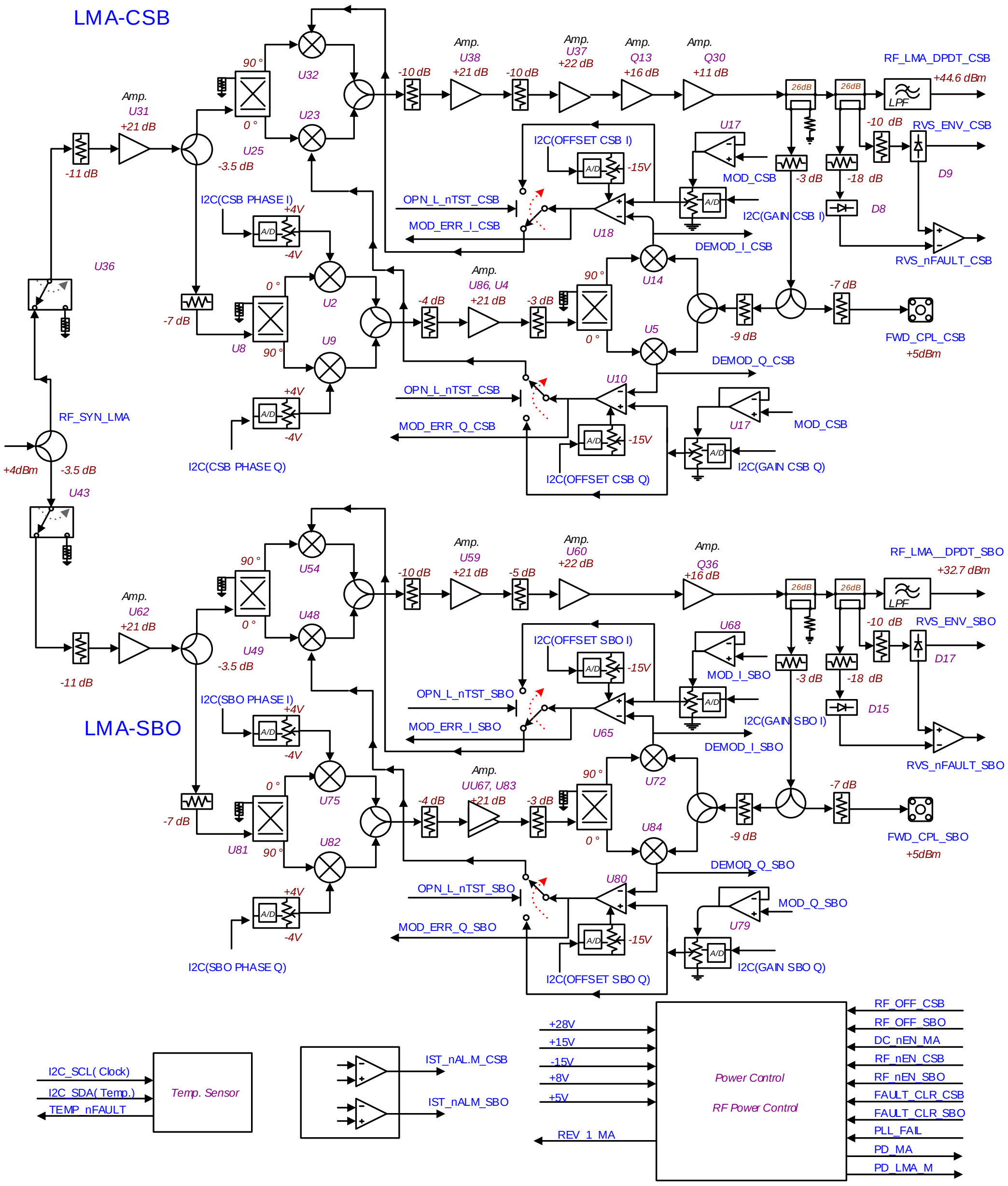

Figure 3-2. LMA Detailed Block Diagram

LMA carries out the following functions:

- High-power amplification of RF signal.
- Closed-loop feedback amplitude modulation.
- Detect reverse / forward signal by sampling the RF signal through the output coupler.
- Adjust the DC offset of the Demodulator.
- Adjust the local phase of the Demodulator.
- LMA temperature measurement and temperature protection.
- Detect any instable alarm.

The LMA-CSB and LMA-SBO have identical functionality with few differences mentioned below.

The CSB gets the MOD_CSB signal as the input from MSG, while the LMA-SBO receives two signals from MSG: one is MOD_I_SBO and the other is MOD_Q_SBO. The phase has been fixed at 45° for CSB section. Also the LMA-CSB has an additional high-power amplifier Q30 in the drive amplification stage.

The LMA comprises of the following major blocks- two I/Q modulators and one I/Q demodulator based on Gilbert-cell mixer and two error amplifiers. There are power amplifiers to provide high-power amplification, a LPF and directional couplers.

The LMA uses power amplifiers to perform high-power amplification of the incoming RF signal in CSB and SBO amplifier sections. The input RF signal of +4 dBm (from SYN) is amplified to +44.6 dBm (28.8Watt max.) in CSB and to +32.7 dBm (1.86 Watt max.) in SBO.

LMA performs amplitude modulation using closed loop Cartesian feedback amplifiers, I/Q (in-phase and quadrature) modulators and demodulators. The signal from the MMIC AMP U31 gets divided into two paths.

- Amplitude Modulation and high-power amplification path
- Local phase adjustment and demodulation path

<u>Amplitude Modulation and high-power amplification path</u>

One of the outputs of the U31 is fed to I/Q modulator. In the I/Q modulator, the signal is divided by a 90° hybrid coupler into two signals, one having a phase difference of 0° in-phase component (I) and the other having a phase difference of 90° quadrature component (Q). The MOD_CSB modulation signal is provided by the MSG and is fed to the second input of both I and Q modulators (U32 and U23) via an error amplifier.

The CSB audio waveform generated by MSG consists of a DC level, the 90 Hz±150 Hz tones and 1020 Hz Ident tone. This input DC level sets the desired RF carrier power and is applied to one of the differential inputs of error amplifier U18 and U10. The sampled RF output obtained from directional coupler via I/Q demodulator (U14 and U15) is applied to the second input. This detected DC level is proportional to the actual RF carrier power.

Similarly, the level of 90 Hz and 150 Hz tones, relative to the DC level, at the error amplifier input sets the desired modulation percentage for each tone.

The error amplifier amplifies the difference between the two signals and the output voltage is applied to the modulator. In this manner a closed loop feedback system continuously detects and compensates for any deviation in the modulation percentage or RF power.

The output of I/Q modulator is combined and routed through a series of amplifiers for high-power amplification (U38, U37, Q13, and Q30). The output of the amplifier stage is fed to a directional coupler which provides samples of the forward and reflected RF output signals. The signal from the coupler is then applied to a LPF to remove undesired harmonics from the transmitter output. This signal is the CSB output.

<u>Local phase adjustment and demodulation path</u>

The second output from the MMIC amp is fed to another I/Q modulator via the 90° hybrid coupler (U8). The MSG provides the local phase control for I and Q signals, CSB PHASE I and CSB PHASE Q signals. The resulting output of the mixers is amplified and applied to the demodulator after amplification by U86, U4. This signal contains the unmodulated carrier from synthesizer. The second input of I/Q demodulator comes from RF output sample from the directional coupler. It contains the RF carrier and any phase modulation components.

The demodulator detects any undesired phase modulation and provides two outputs: an I output proportional to the in-phase modulation components of RF signal and a Q output proportional to the quadrature modulation components of RF signal. These are applied to one of the differential inputs of the error amplifiers for I (U18) and Q (U10) signals respectively.

Thus the local phase adjustment and demodulation path has two main functions:

- Set and maintain the phase relationship between the input RF carrier signal and the modulated output carrier.
- Compensate for any undesired phase modulation of RF carrier occurring in linear RF power amplifiers.

3.2.2. SYN, 0430-7130

The Frequency Synthesizer generates the main carrier signal locked to a stable frequency source by means of a phase locked loop (PLL). The SYN comprises of a TCXO, DDS, PLL and VCO for generating a stable frequency.

The output frequency is programmable in the range of 108 MHz to 118 MHz with 50 kHz spacing for localizer. For the stable frequency source, a temperature-controlled crystal oscillator (TCXO) is used. To maintain phase/frequency coherence across the entire system, a single common reference frequency source is used for the carrier, upper sideband and lower sideband. The temperature sensing device outputs constant frequency regardless of the temperature changes.

The TCXO reference signal is used to generate the course frequency (CRS) which is 4 kHz above the desired channel frequency, and clearance frequency (CLR) which is 4 kHz below the desired channel frequency. The CRS and CLR frequency is fed to the LMA CRS and LMA CLR respectively. The CLR frequency is locked to carrier frequency to provide an 8 kHz frequency separation.

<u>Direct Digital Synthesis</u>

The 500 ILS uses DDS technology for the purpose of increasing the accuracy of the output frequency of the PLL. The DDS circuit is composed of a phase accumulator, a Lookup table ROM and DAC. Figure 3-3 shows the SYN block diagram.

The phase accumulator consists of a register whose contents are updated once each clock cycle. The output of the phase accumulator serves as the address to a sine-look-up-table. Each address corresponds to a phase point from 0° to 360°. Thus the look-up table stores the corresponding digital amplitudes for one complete cycle of a sine wave. The digital amplitudes are then converted to an analog sinusoidal signal in the DAC.

- The DDS output is then applied to a PLL. The PLL and VCO work in a feedback loop where the generated frequency is compared with the RF output from VCO .The resulting error output is amplified and applied to VCO. The VCO reduces the error voltage until the frequency loop is locked and the RF output is said to be phase locked. A low pass filter removes undesirable harmonics and a band pass filter is used to obtain a specific localizer frequency for the station.

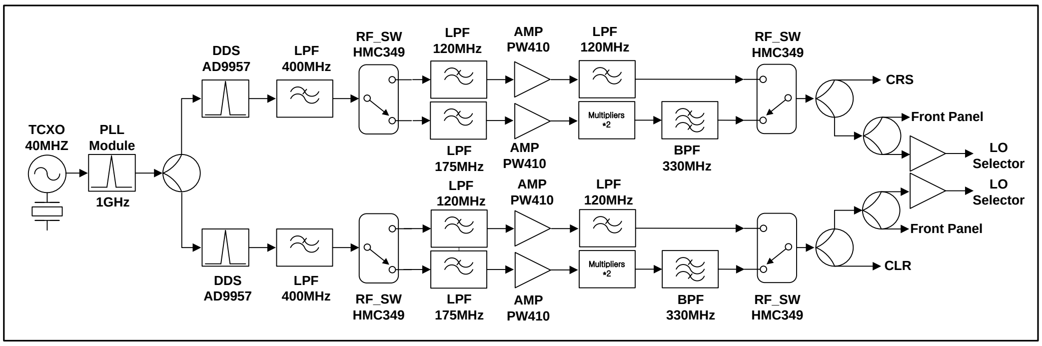

Figure 3-3. Block Diagram of SYN

The generated RF signal is divided into two paths and one of them is fed to phase shifters so that its RF phase offset is adjusted. The RF phase offset is programmable by the operation software. The output of the phase shifters is then fed to the modulator, where the signal gets modulated and power is amplified.

3.2.3. MSG, 0130-7510

The MSG generates the modulation signals for both CSB and SBO. Also, the MSG is equipped with a high performance microprocessor-based controller, which controls and monitors the modulation amplifier subsystem and the antenna electronics subsystem.

The MSG consists mainly of the following functional units:

- Microcontroller and peripheral logic
- Modulation Signal Generator
- Control Software

The 12-bit analog-to-digital converters inside the microcontroller are used to read and monitor RF power levels. The 12-bit multiplying digital-to-analog-converters connected to the microcontroller are used to set up power levels, modulation depths, and RF phase offsets. The MSG also performs the BITE functions and reports the results to the LCU via an internal CAN bus.

The major functions of the MSG are as follows:

- Setting up the PLL/DDS frequency synthesizers
- CSB and SBO output power level monitor and control
- RF output on/off control
- Modulation depth control
- RF phase offset control
- Monitoring the ambient temperature

The Figure 3-4 shows the MSG block diagram for 510/520 LOC.

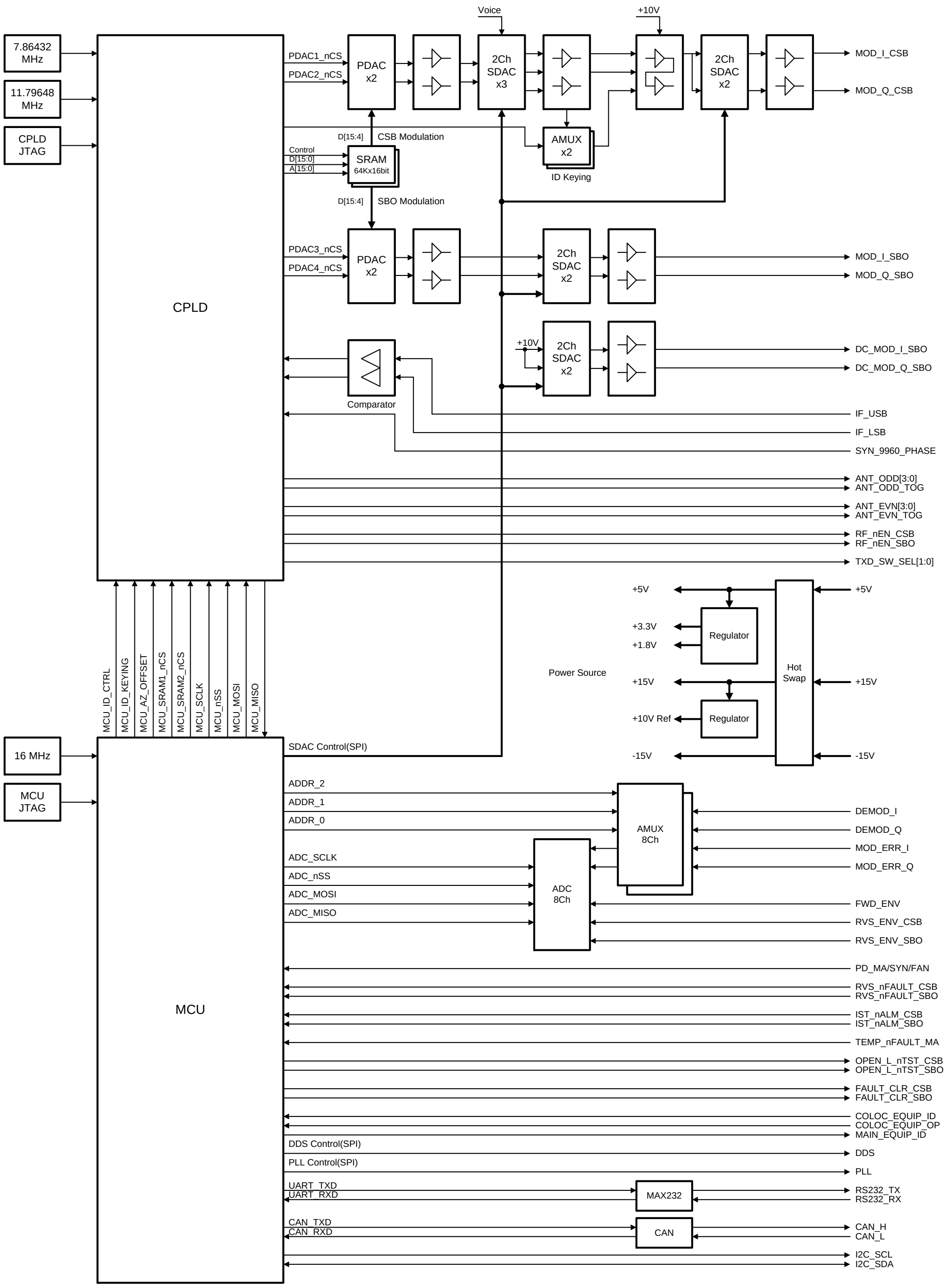

Figure 3-4. 510/520 LOC MSG Block Diagram

<u>Modulation Signal Generation</u>

All the modulation signals including the composite signal for the carrier and sideband blending signals are synthesized numerically by using the direct digital synthesis (DDS) technology.

A general DDS consists of a phase accumulator, a waveform data table and a digital-to-analog converter. All the associated digital logic for the modulation signals DDS including the phase accumulator is embedded in a large-scale complex programmable logic device (CPLD).

For the composite signal, a 90 Hz + 150 Hz sine wave for CSB, a 90 Hz – 150 Hz sine wave for SBO generator and a 1020 Hz sine wave generator are needed. The waveform data for the two signals are stored in the flash memory of the microcontroller (MCU) and two 12-bit digital-to-analog converters (DAC) are employed to produce the analog sinusoidal signals.

Figure 3-5 Shows the Modulation Signal Generating Unit Block Diagram

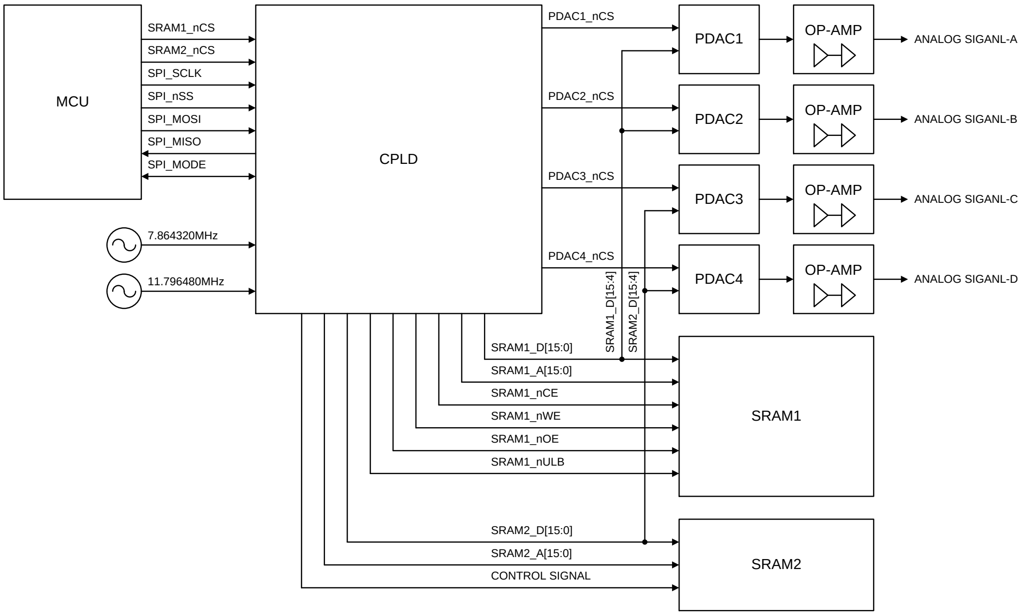

Figure 3-5. MSG - continued

The constant frequency signal generated by reference clock is stored as a value in the waveform data table. These values are sent to a DAC in order to read the data. The data value in DAC is stored in two 64Kx16-bit SRAMs.

For the case of Localizer, even addresses in SRAM1 stores 90 Hz+150 Hz signal data and odd addresses store IDENT 1020 Hz signal data. The SRAM2 uses only even addresses and it stores 90 Hz-150 Hz signal data.

The addresses from SRAM1 and SRAM2 are read separately from the Parallel Interface DAC (PDAC). The output of PDAC is a current output, so it is followed by an op-amp to produce the voltage output of the corresponding analog sinusoidal signal. The following are the output of the Modulation Signal Generating Unit:

- Analog Signal-A: 90+ 150 Hz (for CSB)
- Analog Signal-B: 1020Hz IDENT
- Analog Signal-C: 90- 150 Hz (for Course SBO)
- Analog Signal-D: 90- 150 Hz (for Clearance SBO)

<u>AM Depth Control of CSB Modulation Signals</u>

The modulation depth of the generated CSB modulation signals is controlled by Serial Interface DACs (SDAC). Figure 3-6 shows the Modulation control block diagram.

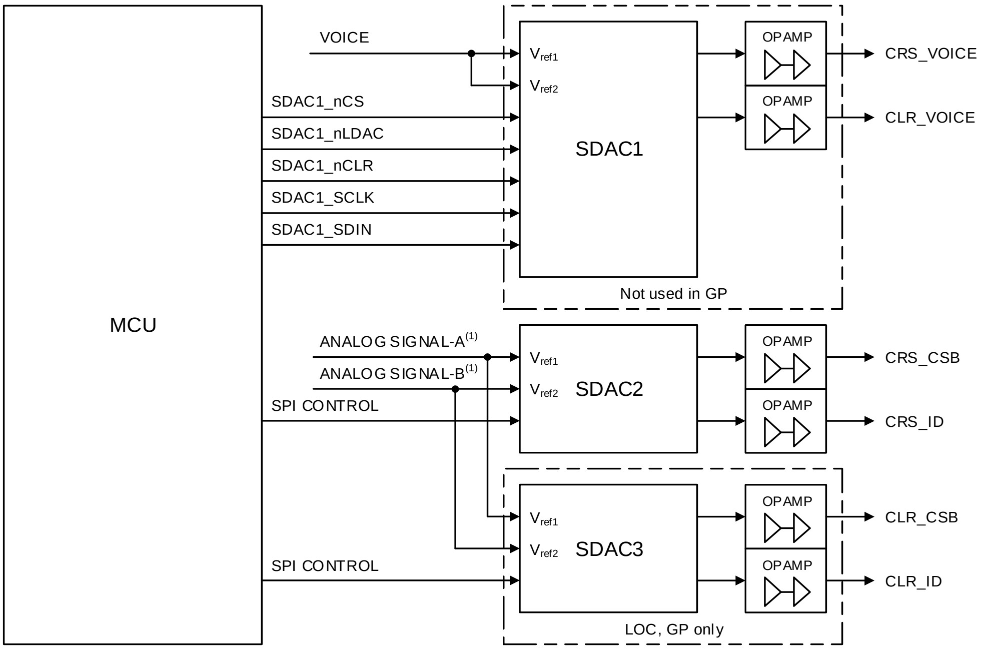

Figure 3-6. MSG - continued

The CSB modulation signals generated are applied to the reference voltage inputs Vref1 and Vref2 of the serial Interface DAC (SDAC). The SDAC controls the modulation depth of each channel of reference voltage by adjusting the amplitude of the input signal. Each SDAC operates under the control of the microcontroller MCU and produce a voltage output using an op-amp.

The CSB modulation signal is separated into course (CRS) and clearance (CLR) modulation signals in SDAC2 and SDAC3 under microcontroller control signal SPI CONTROL. SDAC1 controls the modulation depth of the voice modulation signal in a similar process as mentioned above.

<u>Output Level & Phase Control of SBO Modulation Signal</u>

The SDAC 4 controls the modulation depth and phase of the SBO modulation signal under MCU's SPI CONTROL signal. Only SDAC 4 is used in case of Localizer.

The 90 Hz-150 Hz signal is applied to both inputs Vref1 and Vref2 of SDAC 4. The amplitude and phase of the SBO in-phase (I) and quadrature (Q) signals is adjusted in SDAC 4. The output of the SDAC 4 is current output and hence it is followed by an op-amp to produce a corresponding voltage output `MOD_I SBO_1` and `MOD_Q_SBO_1`.

<u>ID Keying</u>

The 1020 Hz IDENT signal keying is done in an analog multiplexer AMUX based on international Morse Code. The ID signal is input either from a collocated DME/TACAN or by MCU controlled MSG signal `MCU_ID_KEYING`.

The multiplexer in the CPLD selects one input based on the `ID_KEYING_CTL` control signal. The output of CPLD is applied to two AMUX, one for course (CRS) and the other for clearance (CLR). The `CRS_ID` and `CLS_ID` obtained from the modulation control block (Figure 3-6) provide the select signal for the respective AMUX.

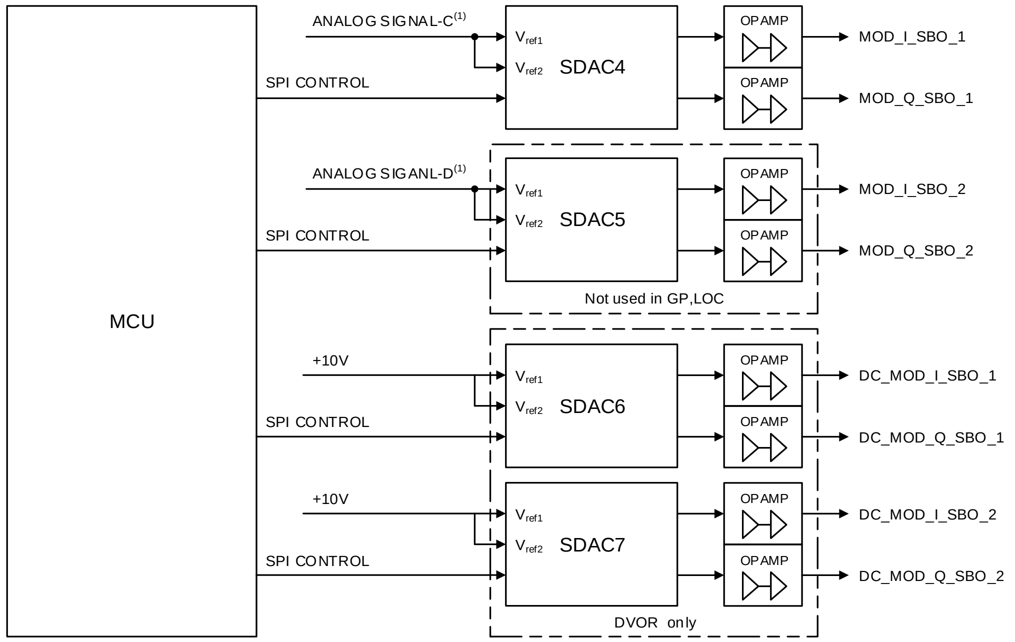

Figure 3-7. MSG - continued

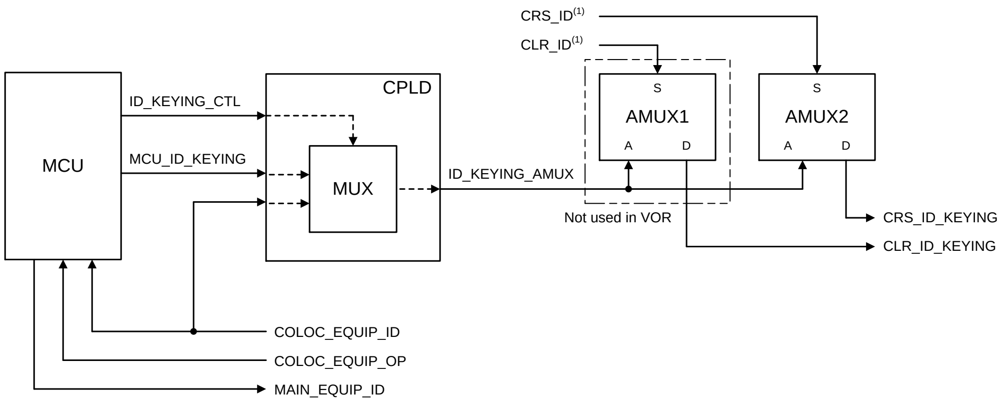

Figure 3-8. MSG - continued

<u>CSB Composite Signal Generation</u>

The composite CSB signal comprises of voice, Ident and (90 Hz + 150 Hz) CSB CRS and (90 Hz + 150 Hz) CSB CLS signals. The output of SDAC 1 and SDAC 2 (Figure 3-6), are applied to the inputs of a summing amplifier. A dc level of +10 V is added to provide biasing to RF amplifier and reduce distortion. The output is followed by an inverting amplifier to produce a composite waveform for modulation of CSB signal

<u>Output Power Control of CSB Composite Signal</u>

The CSB composite signal (I) and CSB composite signal (Q) are applied to two inputs of SDCAs. The course CSB composite signal (I) is applied to one input and the course CSB composite signal (Q) at the other input of SDAC 8.

The SDAC 9 takes the clearance CSB composite signal (I) and the clearance CSB composite signal (Q) signals as the two inputs. The RF level data is converted into analog signal in the SDAC and applied to op-amp where the RF output level of the composite CSB signal is controlled.

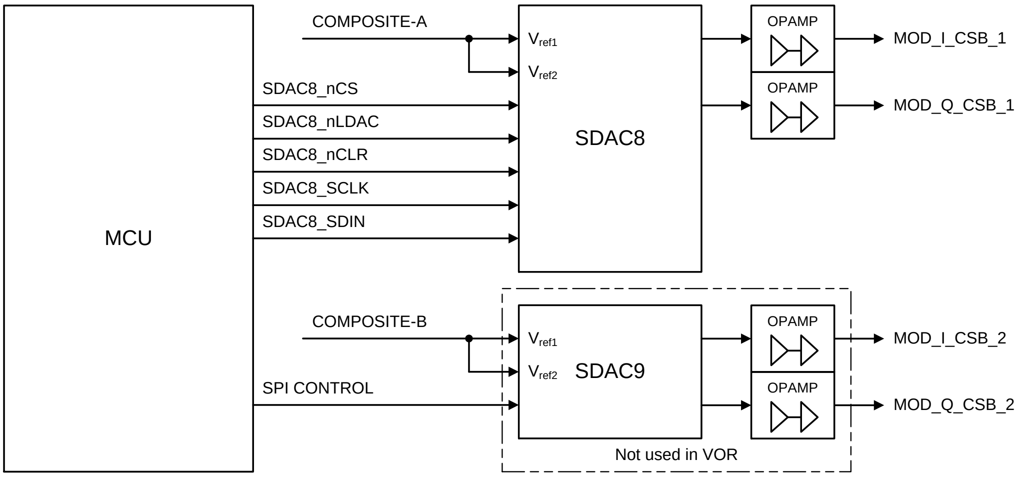

Figure 3-9. MSG - continued

In addition to these functions, the MSG communicates with SYN via MCU SPI Control for PLL and DDS Frequency setup.

The forward and reverse envelope signal monitoring is performed by communication with LMA via the following signals: `FWD_ENV`, `RVS_ENV_CSB`, `RVS_ENV_SBO`, and any fault is reported via `RVS_nFAULT_CSB`, `RVS_nFAULT_SBO`, `FAULT_CLR_CSB`, and `FAULT_CLR_SBO` signals.

The signals `MOD_ERR_I`, `MOD_ERR_Q`, `IST_nALM_CSB` and `IST_nALM_SBO` contribute to the instability modulation alarm monitoring of amplifiers.

The signals `DEMOD_I`, `DEMOD_Q`, `OPEN_L_nTST_CSB` and `OPEN_nTST_SBO` provide control of the amplifier open-loop test of amplifiers.

The temperature monitoring and fan control is done using the signals `TEMP_nFAULT_MA`.

The RF output On/Off control of amplifiers is obtained via `RF_nEN_CSB` and `RF_nEN_SBO` signals.

3.2.4. SCU, 0130-7520

The System Controller Unit, SCU is responsible to control the switching of the transmitters (changeover). It also serves as the communication interface between the control units (CSP, LMI) and remote control unit (RCU, PMDT) and provides the status of the equipment.

The block diagram of SCU is shown in Figure 3-10.

The main functional units of SCU are: Microcontroller and Peripheral Logic and SCU Software.

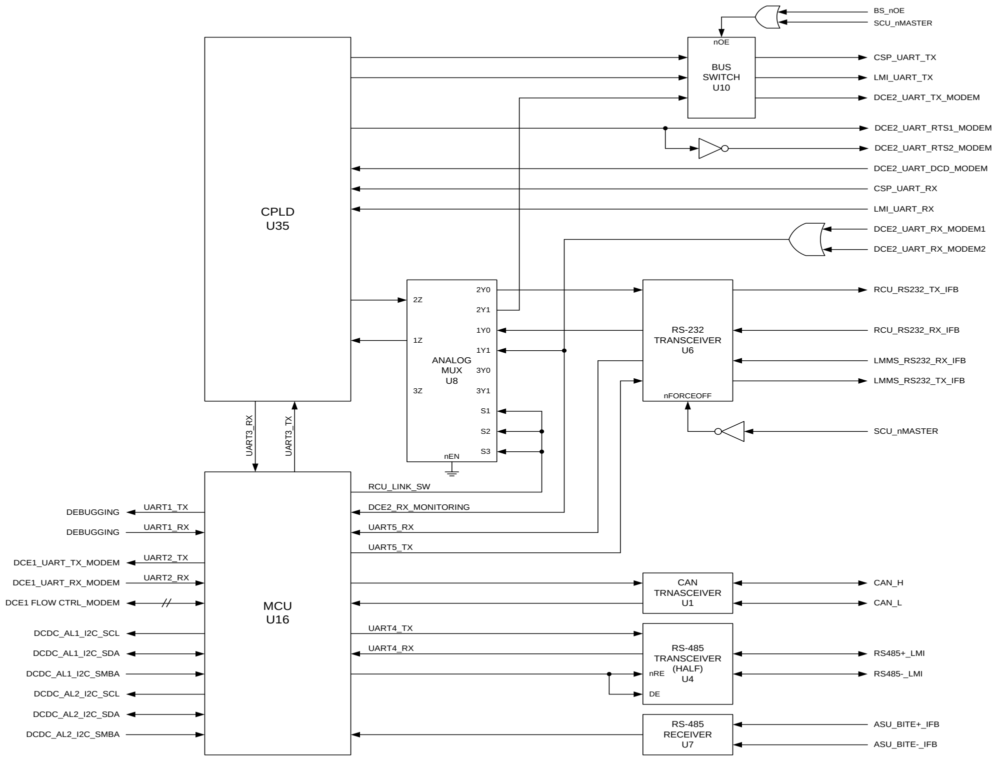

Figure 3-10. SCU Block Diagram

<u>Microcontroller and Peripheral Logic</u>

The microcontroller and peripheral logic are almost identical to those of the MSG and the MON.

The SCU communicates with the MSG and the MON via internal CAN bus, issuing and receiving control commands and responses. For communicating with user both locally and remotely, the SCU is equipped with two RS-232C ports on the rear panel of the system cabinet. Various other communication links including direct null-modem cable, dedicated-line modem, dial-up modem, twisted-pair balanced-line are also supported.

The SCU provides the following communication interfaces

- CAN : MON, MSG, PMM, EMU
- RS-485 : LMI
- Modem : PMDT
- RS-232C : PMDT, Debug

3.2.5. MON, 0430-7550

The MON performs the functions of measurement of the DDM, SDM and RF level and also monitoring the voltage, current and ambient temperature of the subracks.

The MON is operated independently from the transmitter and permanently monitors the system for correct radiation, communicating with the SCU through an internal CAN bus.

The MON changes over the primary transmitter to the standby or switch off the equipment in use when predefined parameters are out of the preset limits and issues a warning or an error depending on the severity.

The block diagram of MON is shown in Figure 3-11.

The MON consists mainly of the following functional units:

- Microcontroller and peripheral logic
- RF front-end module
- Analog signal processing circuitry
- Monitor Software

Each of the above functional blocks is described in the following sections.

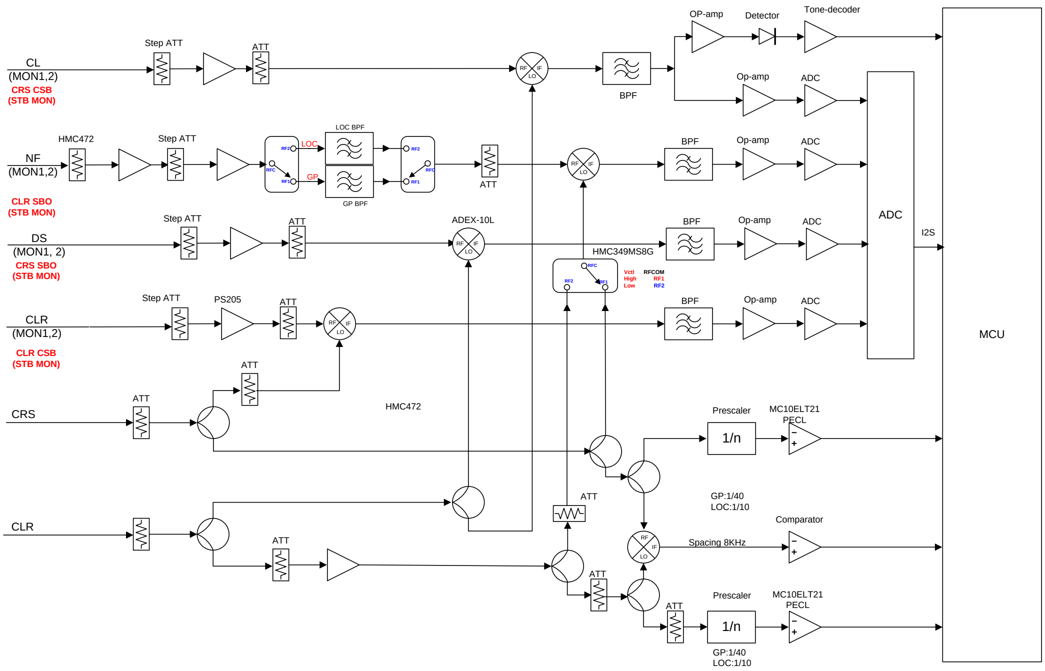

Figure 3-11. MON Block Diagram

<u>RF Front End</u>

The RF Front End consists of the following circuit blocks:

- RF Input Selector Switch
- Down Conversion Mixer
- Local Oscillator Selector Switch
- Low Pass Filter
- Programmable Variable Gain Amplifier
- Down Conversion Mixer for frequency separation detection

<u>Analog Signal Processing Circuitry</u>

The Analog Signal Processing Circuitry comprises the following circuit blocks:

- Switched capacitance filter for 30Hz, 1020Hz
- Signal path selection switches (multiplexers)
- Analog active filter for voice 300Hz~3000Hz

Microprocessor and Peripheral Logic

For analog I/O, a 12-bit digital-to-analog converter and a 12-bit analog-to-digital converter are employed. The ADC is used to take digital samples of the 8 kHz IF signal for digital signal processing. The DAC is used to set up the automatic gain control voltage.

The monitor communicates with the SCU through internal CAN bus.

3.2.6. FFMC, 0432-7580

The Far Field Monitor Controller enables the system to interact with the connected Far Field Monitor (FFM) through serial messages for which it can use a dedicated modem line or RS-232C interface. The FFM parameter values are extracted from the received FFM messages. The FFM parameters integrate with the other monitor parameters for monitor data storage, etc.

3.2.7. EMU, 0130-7540

Environmental Monitoring Unit (EMU) consists of sensors using which it monitors the temperature and other environment conditions. Its function is common to CVOR, DVOR, DME, LOC, GP and the MKR units. It performs the following functions.

- Fire Detector Monitoring using a smoke sensor
- Temperature Measurement and Monitoring using a temperature sensor
- Shelter Door On/Off Status Monitoring using an intrusion sensor
- I/O Pin Interface Control using 16 general-purpose TTL-level digital input/output ports or 8 general-purpose galvanically-isolated digital input/output ports
- Communication with SCU via the CAN bus. The EMU receives the configuration data and setup information of sensors for monitoring from the SCU and exchanges the measurement information and status information of the EMU with the SCU.
- Firmware upgrade

3.2.8. PMU, 0130-7730

The Power Monitoring Unit (PMU) manages the power supplied to the equipment. Two PMU devices are used in order to improve the reliability of the system and either of the two can be used to monitor the AC/DC output. With the help of 7-segment display battery temperature, battery current, battery voltage, AC/DC current, AC/DC voltage, etc. can be displayed. There are selection buttons available in PMU to allow the operator to select the measured value to be displayed on the seven-segment display.

The PMU performs the following functions.

- PM Bus Monitoring
  - The maximum permitted voltage and the output voltage of the AC/DC is set and can be read at the display along with current value and temperature.
  - An AC/DC fault signal is generated if the input/output voltages falls above or below the

set value or the equipment gets overheated due to fan failure. The SCU stores the status register value from PMU and generates an alarm in case of fault.

- If the AC/DC unit has malfunctioned, the PMU switches the power to battery power source. However, the DC/DC is supplied power by the PMU by OR-ing the output of the two PMU in order to improve the reliability. Either of the two PMUs work as master or slave depending on their state and are used to monitor the AC/DC.

- Battery Monitoring and charging control
  - The PMU monitors the charge and discharge state of the battery by measuring its output voltage and current.
  - The PMU transmits alarm information to SCU in case the output voltage of 22V battery decreases and turns off the battery power when it reaches 20V.

- Reporting Monitoring results to SCU
  - The PMU monitors and reports the values of output voltage of AC/DC, current, temperature, fan status, to SCU via CAN bus. PMU also communicates any fault occurred to the SCU.
  - PMU monitors the output and the current status of the battery and reports it to SCU via CAN bus. Depending on the voltage values, PMU communicates with SCU via CAN bus whether to use AC/DC or battery as the power source.
  - Any fault in PMU functioning is also reported to the SCU.
  - Each time hardware in a unit is changed, a revision status signal is generated for the value changed and sent to SCU.
  - SCU receives a control for setting the various parameters of the PMU through the monitor results sent to SCU via CAN bus.

- Control and status indicators on the front panel
  - PMU provides LED display for any fault occurrence, power of AC/DC, charging of battery and PMU status.
  - PMU provides a 7-segment display for the voltage and current measurements.

- Acts as an Interface
  - PMU uses PM Bus (I2C interface) for communicating with AC/DC and communicates via CAN with other units outside the power supply unit.

3.2.9. AC/DC, 3151-0016

The 500 ILS system uses readily accessible Commercial-Off-The-Shelf AC/DC units to ensure recent standards. The AC/DC is a switched-mode power supply (SMPS), which takes 110V/220V AC mains power input and converts it into 28V DC. The 28V power source is fed to the multi-voltage DC/DC converters and also used to charge external backup batteries.

For safety, both over-voltage protection and over-current protection circuits are included.

3.2.10. DC/DC, 0430-7710

The DC/DC converter provides the multi-voltage dc power needed for the transmitter / monitor subrack. The DC/DC unit receives +28V DC input from either AC/DC or battery backup source via PMU subrack and converts it into +5V, +8V, +15V, -15V, +28V output voltages and +50V which is used for VOR/DME only.

3.2.11. DC/DC-A, 0130-7420

The DC/DC-A converter provides the multi-voltage dc power which is needed for the auxiliary electronics subrack. Two DC/DC-A converters are connected in parallel to provide redundancy and current boost. The main functions of DC/DC-A are as follows:

- DC/DC conversion
  - The DC/DC-A unit receives +28V DC input from either AC/DC or battery backup source via PMU subrack and converts it into +5V, +15V, -15V output voltages.
- Monitor the output current and voltage
  - A monitor IC monitors the status of the input voltage and output current and the measured values are conveyed to the SCU
- BITE and Alarm signal
  - A BITE signal is generated to check any abnormal state in the SCU and an alarm is generated and Fault LED (Red) is ON, if any value is outside the tolerance limit.
- Presence Detector (PD)
  - It is possible to determine if any unit has been detached by the signal associated with revision check.

3.2.12. CSP, 0430-7560

The Control and Status Panel (CSP) consists of push buttons and light emitting diode (LED) indicators for control and display of the system status and configuration. Figure 3-7 shows the CSP Front Panel.

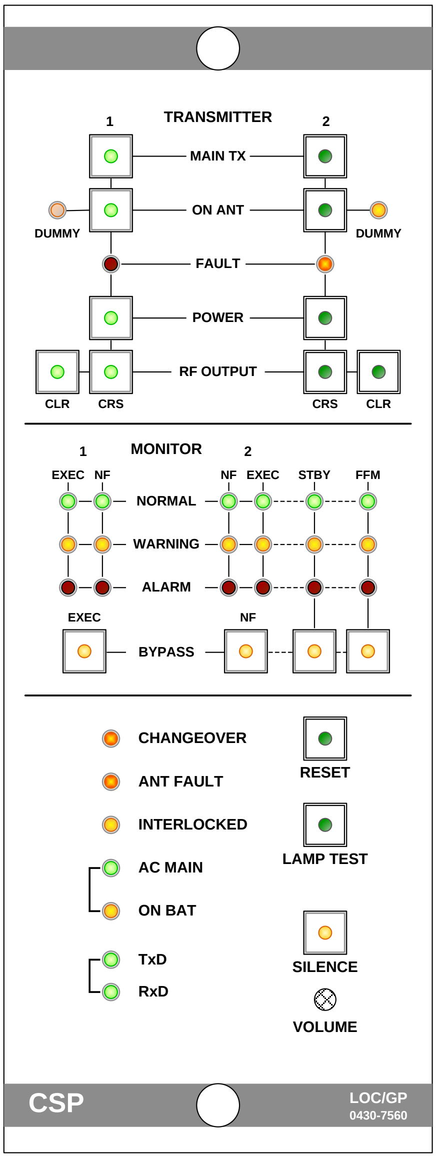

Figure 3-12. CSP Front Panel

The control and indicators on CSP are described in Table 3-1. There are 5 push button controls and 2 LED indicators for each transmitter- TX1 and TX2.

The CSP indications for the monitors provide control and display of EXEC (executive), NF (near-field), STBY (standby) and FFM (far-field) monitor. Each monitor reports the alarm status to CSP and consists of 4 push buttons and 18 LEDs (3 for each monitor). The LEDs for each monitor indicate the normal, warning and alarm states depending on the parameter values measured and tolerance limits set.

There are LEDs to indicate CHANGEOVER in case there has been changeover of transmitter, ANT FAULT for indicating fault in the antenna, and INTERLOCKED to indicate an active interlock in case of mutual exclusive operation on different ILS systems.

The active power source is indicated by either of the 2 LEDs – AC MAIN or ON BAT.

The TxD and RxD LEDs indicate transmission and reception of signals respectively.

There are push buttons for RESET to reset the active transmitter and SILENCE to mute the system. The LAMP TEST switch causes all installed front panel indicator lamps, including those normally inactive in a single-equipment system, to illuminate, so as to avoid confusion with “dark” lamps when performing this test.

A potentiometer knob VOLUME, below the silence button provides volume adjustment.

Table 3-1. CSP description

Signal	Type	Color	Description
MAIN TX	Push Button	Green	It selects either TX1 or TX2 as the active transmitter.
ON ANT	Push Button	Green	It selects the active transmitter, TX1 or TX2, to connect to the antenna for radiation of the signal.
POWER	Push Button	Green	It is used to turn the transmitter TX1 (or TX2) On/Off.
RF OUTPUT CRS	Push Button	Green	It is used to turn On/Off the course signal of TX1 (or TX2).
RF OUTPUT CLR	Push Button	Green	It is used to turn On/Off the clearance signal of TX1 (or TX2).
DUMMY	LED	Amber	It indicates that TX1 (or TX2) is connected to dummy load when not connected to antenna or for maintenance purpose. It works in conjunction with ON ANT push button. The standby TX is automatically connected to dummy load.
FAULT	LED	Red	It indicates any fault in the transmitter TX1 (or TX2), which will then initiate a changeover.
NORMAL	LED	Green	It indicates normal operation of monitor without any alarms.
WARNING	LED	Amber	It indicates that the monitor has detected a warning condition.
ALARM	LED	Red	It indicates that the monitor has detected an alarm condition.
BYPASS	Push Button	Amber	It is used to bypass the monitor for maintenance procedures.
CHANGEOVER	LED	Red	It indicates that there has been a changeover between the TX1 and TX2.
ANT FAULT	LED	Red	It indicates that there is some fault in antenna.
INTERLOCKED	LED	Amber	It indicates an active interlock in case of mutual exclusive operation on different ILS systems. The ILS performs a shutdown and stops transmission of ILS signals.
AC MAIN	LED	Green	I t indicates that active power source is AC Mains supply.
ON BAT	LED	Amber	It indicates that the active power source is backup battery.

TxD	LED	Green (blinking)	It indicates normal transmission of signals.
RxD	LED	Green (blinking)	It indicates normal reception of signals.
RESET	Push Button	Green	It is used to reset the active transmitter TX1 or TX2.
LAMP TEST	Push Button	Green	It is used to perform Lamp Test to check proper functioning of all LED indicators. All LEDs including inactive LED should remain lit throughout the duration the button is pressed.
SILENCE	Push Button	Amber	It is used to mute the system volume.
VOLUME	Potentiometer	_	It is used to adjust the volume.

The Block diagram of CSP is shown in Figure 3-13. The front end panel consists of push-button switches and LEDs and a speaker to hear IDENT tone. The microprocessor logic based on a large-scale complex programmable logic device (CPLD) processes the input commands via switches and indicates the status information via the LEDs.

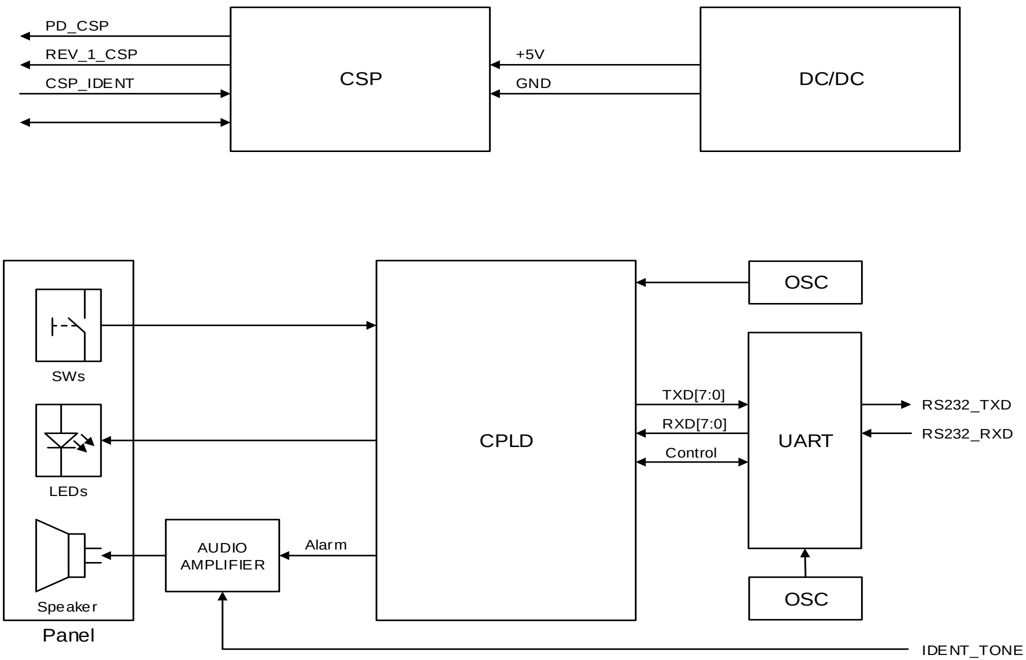

Figure 3-13. CSP Block Diagram

3.2.13. IFB, 0130-3410

The Interface Board (IFC) acts as an interface between devices inside and outside the equipment.

It has the following functions.

- Interface board between devices
  - IFB acts as an interface between the various units inside the equipment such as SCU,

LMI, EMU, MSG, VAU, and FFMC. It also acts as an interface for communicating with external units such as Sensors, collocation equipment, PMDT (maintenance PC, RCU (remote control and monitoring), remote voice, FFM (Far Field Monitor), and any other external devices.

- IFB provides various interface signals via RS-232, RS-485, USB, modem (telephone line), Ethernet, CAN, It also provides additional 8-channel analog input/output and 16-channel digital input/output ports which are reserved for future use.

- Surge Protection
  - IFB uses surge protection to protect the equipment from any unexpected incoming high voltages.
- Photo Coupling
  - Digital input and output signals are photo coupled for insulation from outside.
- ASU power supply interruption
  - In case both TX1 and TX2 shutdown, the SCU is directed to block the +28V DC power being supplied to ASU.

3.2.14. VAU, 0130-7430

The Voice amplifier unit (VAU) serves to filter and amplify the audio signal which is sent to CVOR, DVOR and LOC. It filters frequency in the audible range of 300 – 3,000 Hz using a band pass filter and provides voice compression for limiting dynamic range within 10 dB. Figure 3-14 shows the block diagram of VAU.

VAU takes two voice inputs: one via line receiver and the other from mic input. The voice Line is the default input. When MIC is connected, a SPDT analog switch automatically switches the input to the MIC voice. The selected input signal from the analog switch is pre-amplified to a specified signal level.

The pre-amplifier output is then passed through a band stop filter to suppress the 1020 Hz Ident. It is followed by a Band pass filter where a signal in the desired audio frequency (300 Hz – 3,000 Hz) is obtained. The output of band pass filter is applied to a non-inverting amplifier. The final voice output is sent to both the transmitters TX1 and TX2.

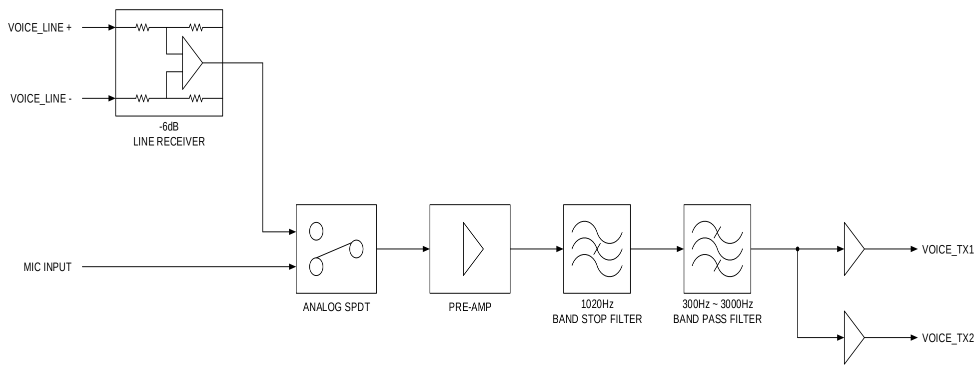

Figure 3-14. VAU Block Diagram

3.2.15. LMI, 0432-7530

The Local Maintenance Interface (LMI) consists of a 10.4" color TFT LCD with touchscreen, light emitting diode (LED) indicators. With the LCD display in combination with the touchscreen, the system status, parameter, monitor data and configuration can be displayed and modified.

LMI has the following functions:

- Equipment status and change settings
  - LMI displays the system status, power supply status and shelter status. It also displays the TX configuration settings and monitor settings.
  - LMI receives commands from the operator via GUI and exchanges it with SCU to carry out changes in the system setting such as TX setting, monitor setting, any setting needed to be changed in sensors inside the shelter and settings of the individual units.
- Log history and query
  - The status of the equipment and individual units are saved in a event log file. The queries made by operator are also recorded in a log file. These information can be used at a later time using LMI to check history of commands and events.
- Unit Firmware Upgrade
  - It is possible to upgrade firmware for all units SCU, PMM, EMU, MSG, MON with the microcontroller MCU.
- Communication Interface with an embedded computer
  - LMI consists of an operator interface GUI in the form of a touch screen display with embedded computer. It is installed on the top of rack door.
  - It provides USB, Ethernet and RS 232 communication interface with PMDT, and RS-232, RS -485 communication interface with SCU.

3.2.16. MODEM, 0130-7420

The Modems provide a communication medium to connect to maintenance PC PMDT. There are two types of modems used for ILS equipment.

- High-Speed (up to 33.6kbps) leased-line/dialup Modem
- Low-speed (1200 bps) FSK leased-line modem

Figure 3-15 shows the block diagram of MODEM.

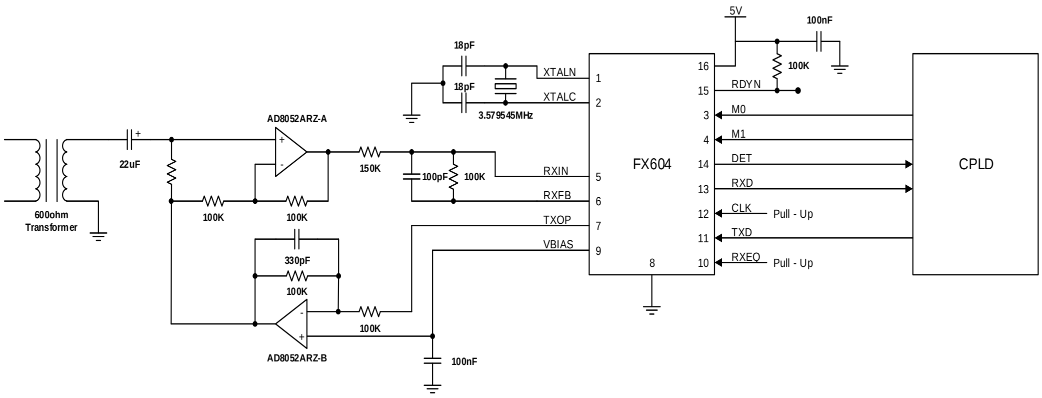

Figure 3-15.   MODEM Block Diagram

4. OPERATION

4.1. INTRODUCTION

The standard operation is carried out using a PMDT PC via RS-232 modem. The basic operation is available locally to the operator using a local maintenance interface (LMI). The Local Maintenance Interface (LMI) consists of a 10.4” color TFT LCD with touchscreen and light emitting diode (LED) indicators. With the LCD touchscreen display, the system status and configuration can be displayed and modified. The PMDT carries out the parameter adjustments and maintenance procedures.

4.2. CONTROL AND INDICATORS

4.2.1. LOCAL MAINTENANCE INTERFACE (LMI)

Figure 4-1 shows the LMI screen. Table 4-1 describes the control and indicators on LMI. The LMI located on the front door of cabinet consists of the following controls and indications.

- A 10.4” color TFT LCD with touchscreen for indication of status of transmitters, monitors, measured parameter values, etc.
- Four indication lamps for the main system- NORMAL, WARNING, ALARM AND MAINTENANCE.
- A key-lock switch to select three operational modes of the station- LOCAL, REMOTE and MAINTENANCE, for operation from local site , remote site and in maintenance mode respectively.

Table 4-1. LMI Control and Indicators

CONTROL/ INDICATOR	COLOUR/ POSITION	FUNCTION	REMARKS
NORMAL	Green	The transmitters and monitors are switched ON and serviceable for normal operation. There is no Warning or Alarm	
WARNING	Amber	The equipment is operating on battery supply BITE warning MON 1 and MON2 are in maintenance/bypass mode	Standby bypass
ALARM	Red	MON1 and MON2 are in Alarm state CSP fault MON 1 and MON2 are in bypass/maintenance mode	There is fault in either transmitter (or antenna) which initiates changeover. If both TX have fault, the system shuts down. The monitors are in executive bypass mode.
MAINT	Green	The equipment is under maintenance mode, either Local or remote.	

Key-Lock Switch	LOCAL	The equipment is enabled for Local operation.	Equipment is not in operation. Parameter values can be read remotely.
Key-Lock Switch	REM	The equipment is enabled for Remote control.	Equipment is in operation but local control commands at LMI are disabled. Parameter values can be read locally.
Key-Lock Switch	MAINT	The equipment is in maintenance mode. MON bypass is set and Alarm indication is switched ON.	Equipment is not in operation.

4.2.2. CONTROL STATUS PANEL, CSP

The Control and Status Panel has the following controls and indications as described below. Figure 4-1 shows the CSP Front Panel.

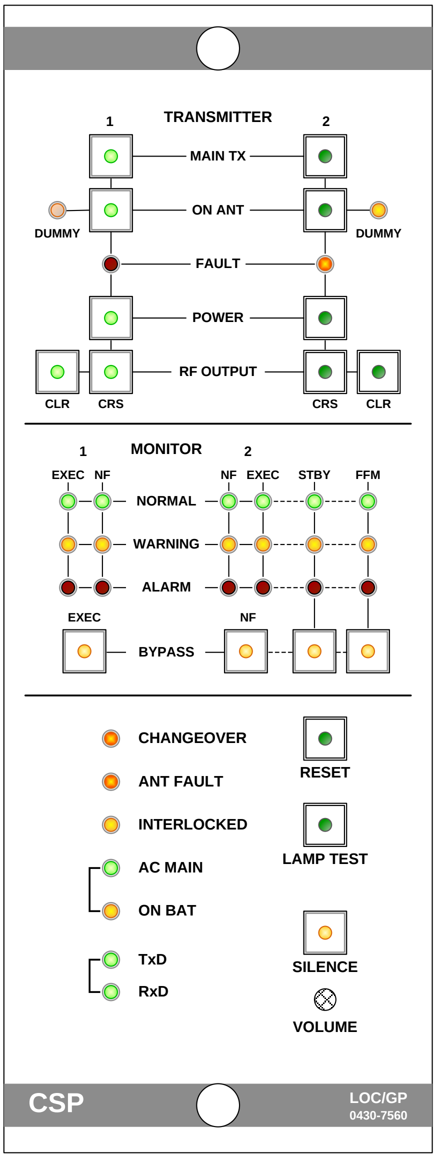

Figure 4-1. CSP Front Panel

4.2.3. LOCALIZER MODULATION AMPLIFIER, LMA

The Localizer Modulation Amplifier has the following controls and indications as described below. Figure 4-2 shows the LMA Front Panel.

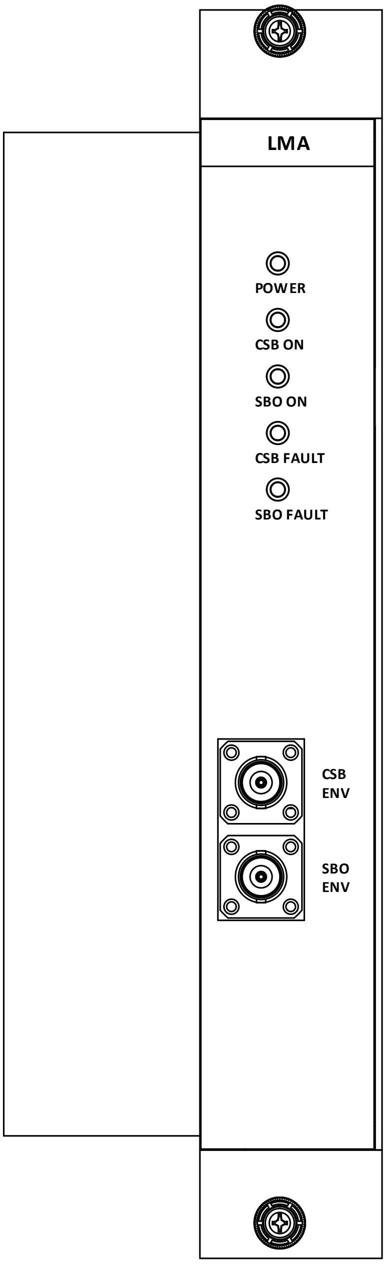

Figure 4-2. LMA Front Panel

The Table 4-3 describes the control and indicators on the LMA of the 510/520 LOC equipment.

Table 4-2. Control and Indicators on LMA

No	Signal Name	I / O	Signal Type	Description
1	POWER	O	ON / OFF	LMA Power Supply Status LED ON (Green) when Power ON
2	CSB ON	O	ON / OFF	RF output status of CSB LED (Green), LED ON @ > +24dBm

3	SBO ON	O	ON / OFF	RF output status of SBO LED(Green), LED ON @ > +18dBm
4	CSB FAULT	O	ON / OFF	Indicates Fault if Reverse CSB signal is detected. LED(Red), LED ON @ > +24dBm
5	SBO FAULT	O	ON / OFF	Indicates Fault if Reverse SBO signal is detected. LED(Red), LED ON @ > +18dBm
6	CSB ENV	O	Analog	CSB Envelope detector output BNC Connector (2V @ 28.8W output Power)
7	SBO ENV	O	Analog	SBO Envelope detector output BNC Connector (2V @ 1.86W output Power)

4.2.4. SYNTHESIZER, SYN

Figure 4-5 shows the SYN Front Panel.

The Table 4-3 describes the control and indicators on the SYN of the 510/520 LOC equipment.

Table 4-3. Control and Indicators on SYN

No	Signal Name	I / O	Signal Type	Description
1	POWER	O	ON OFF	Power status LED (Green) Power ON= LED ON
2	RF ON CRS	O	ON/OFF	CRS RF Output Status LED (Green) CRS RF Output= LED ON
3	RF FAIL CRS	O	ON/OFF	CRS Unlock Detection Signal LED (Red) CRS Unlock Detect= LED ON
4	RF ON CLR	O	ON/OFF	CLR RF Output Status LED (Green) CLR RF Output= LED ON
5	RF FAIL CLR	O	ON/OFF	CLR Unlock Detection Signal LED (Red) CLR Unlock Detect= LED ON

4.2.5. VOICE AMPLIFIER UNIT, VAU

Figure 4-6 shows the VAU Front Panel.

The Table 4-4 describes the control and indicators on the VAU of the 510/520 LOC equipment.

Table 4-4. Control and Indicators on VAU

No	Signal Name	I/O	Signal Type	Description
1	MIC_DETECT	I	TTL(5V)	Detects signal if microphone is plugged -in (High : Normally / Low : Detection)
2	MIC_IN	I	Analog	Microphone Input Signal

4.2.6. DC/DC-A

Figure 4-7 shows the DC/DC-A Front Panel.

The Table 4-5 describes the control and indicators on the DC/DC-A of the 510/520 LOC equipment.

Table 4-5. Control and Indicators on DC/DC-A

No	Signal Name	I / O	Signal Type	Description
1	POWER	O	ON / OFF	Input Power Status Power ON = LED ON (Green)
2	FAULT	O	ON / OFF	Indicates fault if the input voltage is below the set limit Alarm = LED ON (Red)
3	OUTPUT	O	ON / OFF	Indicates that the DC output voltage is atleast the minimum set value Output =LED ON (Green)
4	+5V_TP	O	DC+5V	RED, Test Point Port (+5V)
5	+15V_TP	O	DC+15V	RED, Test Point Port (+15V)
6	-15V_TP	O	DC-15V	RED, Test Point Port (-15V)
7	GND	O	GND	BLACK, Test Point Port (Ground)

4.2.7. PMU

Figure 4-8 shows the PMU Front Panel.

The Table 4-6 describes the control and indicators on the PMU of the 510/520 LOC equipment.

Table 4-6. Control and Indicators on PMU

Item	Type	Description
Battery Temperature	O	Displays Battery Temperature on 7-segment display
AC/DC Voltage	O	Displays AC/DC Voltage on 7-segment display
AC/DC Current	O	Displays AC/DC current on 7-segment display
Battery Voltage	O	Displays Battery Voltage on 7-segment display
Battery Current	O	Displays Battery Current on 7-segment display
Battery In Use	O	LED ON indicates Battery discharge mode
AC Fail	O	LED ON indicates AC Fail mode,
Equalization charging	O	LED ON indication displays Equalizing charge mode
Button1_selected	O	7-segment battery temperature LED selection button
Button2_selected	O	7-segment AC/DC average voltage LED selection button
Button3_selected	O	7-segment AC/DC total current LED selection button
Button4_selected	O	7-segment battery voltage LED selection button

Button5_selected	O	7-segment battery current LED selection button

4.2.8. FAN

Figure 4-9 shows the FAN Front Panel.

The Table 4-7 describes the control and indicators on the FAN of the 510/520 LOC equipment.

Table 4-7. Control and Indicators on FAN

No	Signal Name	I/O	Signal Type	Description
1	LED1	O	ON / OFF	+ 28V power supply status Power ON = LED ON (Green)
2	LED2	O	ON / OFF	FAN1 status Alarm = LED ON (Red), Normal = LED OFF
3	LED3	O	ON / OFF	FAN2 status Alarm = LED ON (Red), Normal = LED OFF
4	LED4	O	ON / OFF	FAN3 status Alarm = LED ON (Red) Normal = LED OFF
5	LED5	O	ON / OFF	FAN4 status Alarm = LED ON (Red), Normal = LED OFF

4.2.9. DC/DC

Figure 4-10 shows the DC/DC Front Panel.

The Table 4-8 describes the control and indicators on the DC/DC of the 510/520 LOC equipment.

Table 4-8. Control and Indicators on DC/DC

No	Signal Name	I / O	Signal Type	Description
1	POWER	O	ON / OFF	Input Power Status Power ON = LED ON (Green)
2	FAULT	O	ON / OFF	Indicates fault that the input voltage is below the set limit Alarm = LED ON (Red)
3	OUTPUT	O	ON / OFF	Indicates the DC output voltage is atleast the minimum set value Output =LED ON (Green)
4	ADJ1	O	DC (variable)	Port for adjusting the output voltage of the main DC + 28V

5	ADJ2	O	DC (variable)	Port for adjusting the output voltage of the main DC + 50V (only VOR, DME)
6	+5V_TP	O	DC+5V	RED, Test Point Port (+5V)
7	+8V_TP	O	DC+8V	RED, Test Point Port (+8V)
8	+15V_TP	O	DC+15V	RED, Test Point Port (+15V)
9	-15V_TP	O	DC-15V	RED, Test Point Port (-15V)
10	+28V_TP	O	DC+28V	RED, Test Point Port (+28V)
11	+50V_TP	O	DC+50V	RED, Test Point Port (+50V, only VOR, DME)
12	GND	O	GND	BLACK, Test Point Port (Ground)

4.2.10. SCU

Figure 4-11 shows the SCU Front Panel.

The Table 4-9 describes the control and indicators on the SCU of the 510/520 LOC equipment.

Table 4-9. Control and Indicators on SCU

No	Signal Name	I / O	Signal Type	Description
1	LED_CSP_RS 232_RX	I	RS-232	UART-CSP Rx communication verification signal LED = Green
2	LED_CSP_RS 232_TX	O	RS-232	UART-CSP Tx communication verification signal LED = Red
3	LED_LMI_RS 232_RX	I	RS-232	UART-LMI Rx communication verification signal LED = Green
4	LED_LMI_RS 232_TX	O	RS-232	UART-LMI Tx communication verification signal LED = Red
5	LED_PMDT_ RS232_RX	I	RS-232	UART-PMDT Rx communication signal LED = Green
6	LED_PMDT_ RS232_TX	O	RS-232	UART-PMDT Tx communication , LED = Red
7	LED_CAN_R XD	I	CAN	CAN Rx communication, LED = Green
8	LED_CAN_T XD	O	CAN	CAN Tx communication, LED = Red
9	LED_PMDT_ MD_RXD	I	TTL	MODEM Rx communication verification signal LED = Green
10	LED_PMDT_ MD_TXD	O	TTL	MODEM Tx communication verification signal LED = Red
11	LED_PMDT_ ETH_TXD	O	TTL	Ethernet Tx communication verification signal LED = Red

12	LED_PMDT_ETH_RXD	I	TTL	Ethernet Rx communication verification signal LED = Green

4.2.11. MSG

Figure 4-12 shows the MSG Front Panel.

The Table 4-10 describes the control and indicators on the SCU of the 510/520 LOC equipment.

Table 4-10. Control and Indicators on MSG

No	Signal Name	I / O	Signal Type	Description
1	TP_CSB_1	O	Analog	CRS CSB Signal (Composite)
2	TP_SBO_1	O	Analog	CRS SBO Signal (90Hz-150Hz)
3	TP_CSB_2	O	Analog	CLR CSB Signal (Composite)
4	TP_SBO_2	O	Analog	CLR SBO Signal (90Hz-150Hz)
5	TP_POWER	O	TTL	Power Status Power ON = LED ON (Green)
6	TP_CAN_RXD	O	TTL	CAN Rx communication, LED = Red
7	TP_CAN_TXD	O	TTL	CAN Tx communication, LED = Red

4.3. TURN ON AND SHUTDOWN PROCEDURES

4.3.1. TURN ON PROCEDURE

This section provides the procedure to Turn ON the LOC equipment and to verify a normal operating state.

The following conditions should be verified before turning ON the equipment.

- Backup Battery BATT 1 and BATT 2 Verify switched OFF
- AC/DC AC MAIN Verify switched OFF, LED OFF
- LMI Key-Lock Switch Verify set to LOCAL
- LMI Key-Lock Switch Verify

4.3.2. INDICATIONS DURING NORMAL OPERATION

** Details will be supplemented.*

4.3.3. SHUTDOWN PROCEDURE / TURN OFF PROCEDURE

** Details will be supplemented.*

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5. STANDARDS AND TOLERANCES

5.1. INTRODUCTION

This section lists and describes the MOPIENS 510/520 LOC standards and tolerances.

5.2. 510/520 LOCALIZER STANDARDS AND TOLERANCES

Table 5-1 provides the system standards and tolerances for the performance checks and maintenance procedures of 510/520 LOC. It is advisable that these parameters be checked at the recommended intervals and maintenance procedures are performed on schedule for efficient performance of the equipment.

Table 5-1. Standards and Tolerances of 510/520 LOC

Parameter	Standard	Tolerance Limit
TRANSMITTER		
Rated Power Output	15 W	
Frequency	Assigned frequency 108 Hz to 111.975 Hz	±0.001 %
Ident		
SUPPLY VOLTAGE		
AC Voltage	110/220 V	9V to 265V 47 Hz to 63 Hz
DC Voltage	28V	22V to 32V
	5V	4.5V to 5.2V
	8V	7.5V to 8.5V
	15V	14.5V to 15.5V
	-15V	-15.5V to -14.5V
Backup Battery	24V	
VSWR	≤ 1.5:1	

** Details will be supplemented.*

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6. PERIODIC MAINTENANCE

This section describes the required performance checks that must be conducted in order to ensure safe operation of MOPIENS 500 ILS equipment. The supervising personnel are responsible for scheduling these performance checks based on the recommended intervals

6.1. ON-SITE PERFORMANCE CHECKS

Table 6-1. Performance Check

Performance Check	**Reference Paragraph**	
	Standards and Tolerance	**Maintenance/Performance check procedure**
MONTHLY		
Voltage and Current checks	Table 5-1	
QUARTERLY		
Monitor parameters		
CSB Modulation Percentage		
SEMI-ANNUALLY		
Operating Frequency		
RF Power		
Monitor Integrity Check		
ANNUALLY		

** Details will be supplemented.*

6.2. OTHER ON-SITE MAINTENANCE

The other maintenance tasks include periodic cleaning and inspection of the shelter and equipment.

It also includes inspection of batteries for corrosion or any kind of deterioration. Periodic checks and tightening of RF and battery connections should also be done to ensure continuous and efficient operation of the equipment.

Check air filters in shelter vent and air conditioning unit. Clean or replace any part if required.

Check the installed environmental sensors to ensure normal functioning.

Perform a complete visual inspection of the equipment, antenna array and distribution network assembly.

7. CORRECTIVE MAINTENANCE

This section includes the troubleshooting procedure and corrective maintenance procedures at the localizer site.

** Details will be supplemented.*

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8. PARTS LIST

8.1. INTRODUCTION

A list of the modules and units used in the 510/520 LOC single equipment configuration is shown in Table 8-1and in Table 8-2 for dual configuration. (Referred Table 1-1 reference labels.)

Table 8-1. 510/520 single equipment configuration part list

Unit Reference	Unit Name	P/N
1	Electronic Cabinet	0431-7002
1A1	AUX Rack	0432-7010
1A1A1	CSP	0432-7560
1A1A2	STBY MON	0430-7550
1A1A3	SCU	0130-7520
1A1A5	EMU	0130-7540
1A1A6	FFMC	0432-7580
1A1A8	DC/DC-A	0130-7720
1A1A10	Modem	0130-7420
1A1A12	VAU	0130-7430
1A1A13	IFB	0130-3410
1A1A14	BP-A	0432-3010
1A2	TX1 Rack	0432-7020
1A2A1/1A2A2 (1A2A2 for 520S only)	LMA	0432-7140
1A2A3	DC/DC	0432-7140
1A2A4	MSG	0130-7510
1A2A5	SYN	0430-7130
1A2A6	MON	0430-7550
1A2A7	FAN	0130-7910

1A2A8	BP-BL	0430-3021
1A2A9	BP-BR	0430-3022
1A4	PMU Rack	0130-7030
1A4A1	PMU	0130-7730
1A4A3	BP-PM	0130-3030
###1A5	AC/DC Rack	COTS
###1A5A1	AC/DC	COTS
1A6	LMI	0130-7530
###1A6A1	IEC-1000	COTS
1A6A2	Interface	0130-7530
1A7/1A9	RF Detector	0130-7330
1A8/1A10	LO Selector	0430-7340
1A11	MON Backend Combiner	0432-7360
1PD1	Power Divider	0430-7370
1RS1/1RS2	RF SP4T Switch	0130-7350
1FL1/1FL2/1FL3/1FL4	Low Pass Filter	0130-7380

** Details will be supplemented.*

Table 8-2. 510/520 LOC dual equipment configuration parts list

Unit Reference	Unit Name	P/N
1	Electronic Cabinet	0431-7002
1A1	AUX Rack	0432-7010

1A1A1	CSP	0432-7560
1A1A2	STB MON	0430-7550
1A1A3/1A1A4	SCU	0130-7520
1A1A5	EMU	0130-7540
1A1A6/1A1A7	FFMC	0432-7580
1A1A8/1A1A9	DC/DC-A	0130-7720
1A1A10/1A1A11	Modem	0130-7420
1A1A12	VAU	0130-7430
1A1A13	IFB	0130-3410
1A1A14	BP-A	0432-3010
1A2	TX1 Rack	0432-7020
1A2A1/1A2A2 (1A2A2 for 520 LOC only)	LMA	0432-7140
1A2A3	DC/DC	0432-7140
1A2A4	MSG	0130-7510
1A2A5	SYN	0430-7130
1A2A6	MON	0430-7550
1A2A7	FAN	0130-7910
1A2A8	BP-BL	0430-3021
1A2A9	BP-BR	0430-3022
1A3	TX2 Rack	0432-7020
1A3A1/1A3A2 (1A3A2 for 520 LOC only)	LMA	0432-7140
1A3A3	DC/DC	0432-7140
1A3A4	MSG	0130-7510
1A3A5	SYN	0430-7130

1A3A6	MON	0430-7550
1A3A7	FAN	0130-7910
1A3A8	BP-BL	0430-3021
1A3A9	BP-BR	0430-3022
1A4	PMU Rack	0130-7030
1A4A1/1A4A2	PMU	0130-7730
1A4A3	BP-PM	0130-3030
1A5	AC/DC Rack	COTS
1A5A1/1A5A2	AC/DC	COTS
1A6	LMI	0130-7530
1A6A1	IEC-1000	COTS
1A6A2	Interface	0130-7530
1A7/1A9	RF Detector	0130-7330
1A8/1A10	LO Selector	0430-7340
1A11	MON Backend Combiner	0432-7360
1PD1	Power Divider	0430-7370
1RS1/1RS2	RF SP4T Switch	0130-7350
1FL1/1FL2/1FL3/1FL4	Low Pass Filter	0130-7380

** Details will be supplemented.*

9. INSTALLATION AND SETUP

9.1. INTRODUCTION

The site must be carefully selected and prepared for the installation of ILS. Prior to the installation work, the equipment should be removed from shipping containers and unpacked for inspection as soon as possible to ensure that it is complete and intact in terms of numerical quantity and mechanical quality. Any discrepancy or damage shall be immediately reported. Each inspected item is to be repacked to prevent damage and kept in a dry storage until they are unpacked again as needed during the installation procedure.

Equipment grounding, main commercial power supplies, antenna mast and the input/output (I/O) connections shall be ready as appropriate. Depending on the beacon configuration selected and the options used, it may be necessary to connect the facility to the associated equipment or to other equipment.

9.2. SAFETY PRECAUTIONS

To avoid any possible accidents, strict attention should be paid to safety regulations issued by the local authorities and the following safety rules should be observed:

- Keep the safety tools (given below) ready and wear them as considered appropriate.
  - Goggles, safety gloves, sturdy shoes, safety helmets and etc.
- For emergency situation, everyone working on the installation site should be aware of:
  - escape routes (Escape routes should always be cleared)
  - the places where the First Aid Kit and Fire Extinguisher are kept in, and
  - emergency contacts such as the nearest casualty doctor, eye specialist and fire station.
- Any pointed or sharp objects are to be removed from clothing pockets while working on the site.
- Remove chains and rings especially when working with electrical devices.
- Beware of electricity.
  - Electrical devices and extension cables should be checked before you use them.
  - Fuses are to be removed before working on the main power supply.
- Alcohol is strictly prohibited.
  - Do not allow any type of alcohol to be carried into the installation site.
  - Anyone under the influence of alcohol will not be tolerated on the installation site.
- Orderly arrangement and proper use of tools
  - Sand off burr from chisels and punches.
  - Test striking tools for tightness of fit.
  - Always check ladders and planks carefully before use.
  - Do not tread on protruding plank sections.
  - Remove protruding nails, strips, etc. immediately.
  - Never leave objects on scaffolding or ladders.
  - Erect sturdy scaffolding and frames and always test them thoroughly before using them.

- When the shelter (equipment room) is unoccupied, it should be locked.

9.3. CRITICAL AND SENSITIVE AREA

In order to install LOC antenna and shelter, must be selected its location in consideration of Critical and Sensitive Area as Figure 9-1 below.

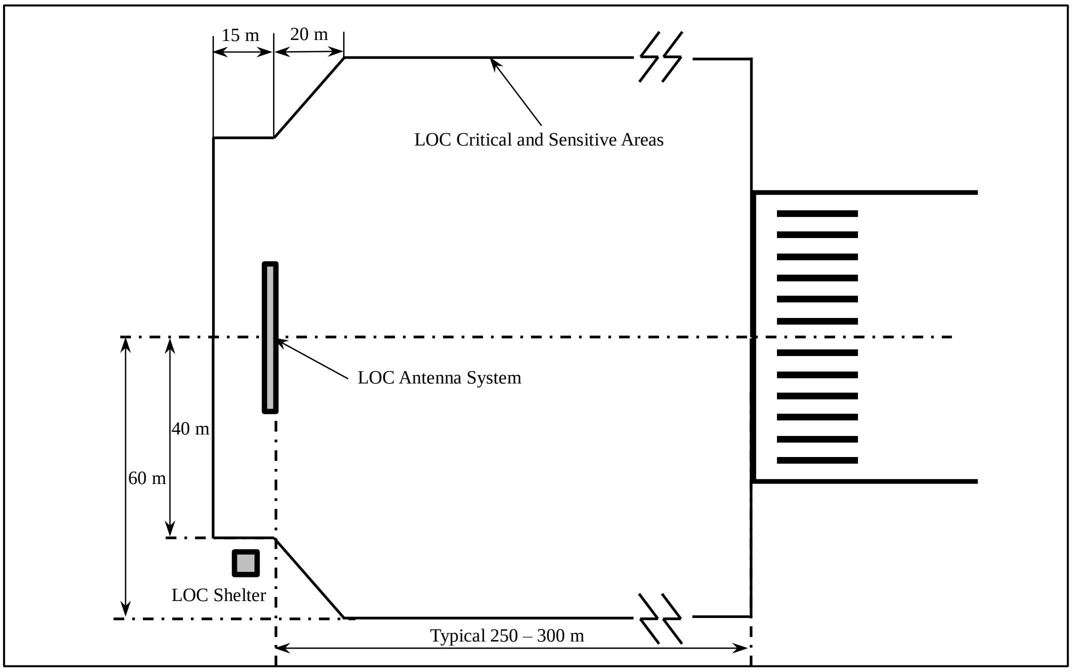

Figure 9-1. Typical LOC Critical and Sensitive Area

9.4. GROUNDING

9.4.1. GENERAL

The type of grounding implemented is dependent on the local terrain. Consequently it is only possible to provide general guidelines here. Grounding conductors or rods are metallic elements of a particular form which are either driven into the ground or laid in the ground so as to cover a relatively large area. All connections in the ground must be welded and protected against corrosion. The ground resistance required for a ILS (or other navigation installations) can be given as < 5 Ω. This resistance can only be measured precisely with the aid of special ground resistance measuring equipment. The exact measuring procedure is described in the operating instructions for these devices. When estimating the ground resistance the length and extent of the network laid are the crucial points, not the cross－sectional area of the conductors. Favorable resistance conditions are provided by arable land and loamy ground (ground resistivity 100 Ω per meter). The data specified below applies to these conditions. With other types of terrain the factors below must be taken into consideration (increase in the resistance with respect to the basic values stated).

- Moist sandy soil 2x
- Dry sandy soil 5 to 10x
- Gravel or stones up to 30x

If the ground is not chemically neutral, e.g. if it is salty, it may be necessary to coat all metal parts laid in the ground with lead or to use a sufficiently non-corrosive steel (e.g. V2A). The different types are as follows:

9.4.2. GROUND RODS

Ground rods are either pipes or U, L or T-shaped profiles driven vertically into the ground and 1 to 2 m in length. It is necessary to connect several ground rods together in order to reduce the grounding resistance. The minimum spacing is twice the length of each ground rod.

－ Material: Steel (hot galvanized) Pipe 30 x 3 mm

Bracket L 65 x 65 x 7 mm

U－profile U 65 DIN 1026

T－profile T 60 DIN 1024

－ Probable grounding resistance of a rod: Length 1 m approx. 70 Ω

Length 2 m approx. 40 Ω

The material, cross sectional areas and grounding resistance of the connecting leads to the shelter should be as for strip ground conductors. When pipe-type grounding rods are fastened with clamps, screws at least M10 in size should be used.

9.4.3. GROUND PLATES

Ground plates are solid perforated sheet metal plates with dimensions of approx. 0.5 x 1 m or 1 x 1 m, which are embedded vertically in the ground. The top edge of the plates should always be at least 1 m below the surface. Several ground plates must be connected in parallel in order to reduce the grounding resistance. The minimum spacing should be 3 m. Material:

－ Sheet steel (hot galvanized) min. thickness 3 mm

－ Sheet copper min. thickness 2 mm

The ground resistance of a plate 1 m^2 is approx. 30 Ω.

9.4.4. ESTIMATING THE GROUND RESISTANCE

They should be considered as parallel resistances. The resulting grounding resistance should then be calculated as follows: $1/R_{res} = 1/R_1 + 1/R_2 + 1/R_3 + ... + 1/R_n$. Taking into account the nature of the terrain satisfactory grounding conditions can be assumed if the ground resistance calculated from the base data is < 5 Ω. If the value calculated is 5 Ω or more, measuring the ground resistance is recommended.

9.4.5. MEASURING THE GROUND RESISTANCE

Three measurements must be performed over a large area in order to determine the ground resistance precisely. The distance between two auxiliary grounds required must be large in relation to the complete ground network of the navigation installation. Two steel rods approx. 1 m long should be used as auxiliary grounds (reinforcing bars); these should be driven into the ground with only a few centimeters remaining at the designated points. It is essential that the rods are of equal length and are driven in to the same depth.

Measurements are performed as shown in the diagram below:

E = Installation ground

H_1= Auxiliary ground 1

H_2= Auxiliary ground 2

M_1= Measured value 1

M_2= Measured value 2

M_3= Measured value 3

Measured value 1: Resistance between installation ground and auxiliary ground 1

Measured value 2: Resistance between auxiliary ground 1 and auxiliary ground 2

Measured value 3: Resistance between installation ground and auxiliary ground 2

When the three measurements have been performed the ground resistance is calculated as follows:

Ground resistance = (corr. meas. 1 + corr. meas. 3 − corr. meas. 2) / 2

The measurement is falsified by the resistance of the two test leads. The cross−sectional area of the test leads should not be less than 1.5 mm^2 in order to ensure an adequate breaking strength. With this cross−sectional area and an assumed length of 2 x 25 m = 50 m, the falsifying resistance would be 0.58 Ω. This resistance should therefore be measured and deducted from measured values 1, 2 and 3. The measured values corrected in this manner are entered into the above formula.

** Details will be supplemented.*