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Integrated Automation System

System Specification

Volume -

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Tables

To be defined

References

[1] **Title:** **Technical Specification**
Description: Technical Specification between Schelde Naval Shipbuilding and IMTECH Marine & Offshore
Ref.: I 1005
From: Schelde Naval Shipbuilding
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[2] **Title:** **Documentation Plan**
Description: TNI-AL Documentation Plan
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[3] **Title:** **IAS System Specification**
Description: Overall System specification of the Integrated Automation System
Ref.: 190134-4000-IAS-SSC
From: E.J. Middeldorp
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[4] **Title:** **IPMS Functional Specification**
Description: Functional specification of the Integrated Platform Management System.
Ref.: 190134-4380-FSC
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[5] **Title:** **IPMS Technical Specification HMI**
Description: Technical Specification of the Human Machine Interface of the IPMS
Ref.: 190134-4380-HMI-TSC
From: R. Langeveld
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[6] **Title:** **IPMS Technical Specification ELP**
Description: Technical Specification of the Element Processing of the IPMS
Ref.: 190134-4380-ELP-TSC
From: R. Langeveld
Issue: V1.0
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[7] **Title:** **PMS Functional Specification**
Description: Functional Specification of the Power Management System.
Ref.: 190134-3900-FSC
From: C. Schouten
Issue: V1.0
Date: <>

[8] **Title:** **PCS Functional Specification**
Description: Functional specification of the Propulsion Control System.
Ref.: 190134-2520-FSC
From: R. Bipat
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[9] **Title:** **Network Architecture CSN and PDN**
Description: Network architecture of the IAS, Client Server Network (CSN) and Platform Data Network (PDN)
Ref.: 190134-4000-CFS-001
From: A.H. de Groot
Issue: V2.0
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[10] **Title:** **Navigation System Interface Specification**
Description: Interface Specification for all external interfaces of the navigation functions
Ref.: 190134-4200-ISC
From: H.J. Tigchelaar
Issue: 2.0
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[11] **Title:** **IPMS List of Control and Monitoring signals**
Description: List with Input/Output signals of the IPMS
Ref.: 190134-4380-IOL
From: E.J. Middeldorp
Issue: V1.0
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[12] **Title:** **Item Survey List**
Description: States the defined items and their characteristics, such as dimensions, weight, and allocation on board
Ref.: 190134-4000-ISL
From: E.J. Middeldorp
Issue: V1.0
Date: <>

[13] **Title:** **IPMS User Manual**
Description: An operator guide that describes the entire user scoped IPMS functions.
Ref.: 190134-4380-UM
From: R. Langeveld
Issue: V1.0
Date: <>

Abbreviations

ACS	Automatic Control Sequence
AIS	Automatic Identification System
ALP	Alarm presentation
AP	Autopilot
ARPA	
C&M	Control & Monitoring
CAP	Component Assist Presentation
CCTV	Closed Circuit Television
CIP	Component Information Presentation
CFS	Network Diagram
COTS	Commercial Of The Shelf
CPM	Citadel Pressure Monitoring
CPP	Controllable Pitch Propeller
CSN	Client-Server Network
DE	Diesel Engine
DG	Diesel Generator
DTL	Data Logger
ECDIS	Electronic Chart Display & Information System
ELP	Element Processing
ESB	Emergency Switchboard
FAC	Function Allocation
FAT	Factory Acceptance Test
FDS	Fire Detection System
FO	Fibre Optic
FSC	Functional Specification
GAP	General Arrangement Plan
GCB	Generator circuit breaker
GCU	Generator Control Unit
GPS	Global Positioning System
HAT	Harbour Acceptance Test
HMI	Human Machine Interface
HMT	Health Monitoring
IAS	Integrated Automation System
IMO	Imtech Marine & Offshore
IPMS	Integrated Monitoring & Control System
INFRA	Infrastructure
IO	Input/Output
IPMS	Integrated Platform Management System
LAN	Local Area Network
LPU	Local Processing Unit
MCR	Machinery Control Room
MCS	Master Clock System
ME	Main Engine
MIP	Mimic Presentation
MJPEG	Motion-JPEG (video standard)
MOB	Man Over Board
MSB	Main Switch Board
NAVRAD	Navigation Radar
NBC	NBC Monitoring
NBCD	Nuclear, Biological, Chemical Damage
NRS	Navigation Radar Server
NSIU	Navigation System Interface Unit
PCM	Platform Control & Monitoring
PCS	Propulsion Control System
PDN	Platform Data Network
PDR	Preliminary Design Review
PLC	Programmable Logic Controller
PMS	Power Management System
PS	Portside
SAT	Sea Acceptance Test
SB	Starboard
SFTP	Shield Folded Twisted Pair
SRM	Safety Related Message
SSC	System Specification
TBD	To Be Defined
TMS	Tank Monitoring System
TRE	Trending
UniMACS	Universal Monitoring And Control System
UPS	Uninterruptible Power Supply
UTC	Coordinated Universal Time

Updates

Underneath are the updates indicated of those parts, which have been changed related to the previous release.

Issue:	Date:	Change:	Reason:
V1.0	09-May-2005	Initial version	PDR milestone

Lloyd's Certificates, Approvals and Appraisals

A list of IAS related documents that Imtech will be providing to Lloyds are stated below. The complete list of all documents that will be provided within the TNI-Al project is stated in the documentation plan [2].

Item	Document code	Description
1	190134-DCL-001	Documentation Plan
2	190134-4000-IAS-SSC	System Specification IAS
3	190134-4380-FSC	Functional Specification IPMS
4	190134-4380-HMI-TSC	Technical Specification IPMS HMI
5	190134-3900-FSC	Functional Specification PMS
6	190134-2520-FSC	Functional Specification PCS
7	190134-4000-CFS-001	Network Architecture CSN and PDN
8	190134-4380-IOL	IPMS List of Control and Monitoring signals
9	190134-4000-ISL	Item Survey List
10	<>	FAT procedures
11	<>	FAT records
12	<>	HAT procedures
13	<>	HAT records
14	<>	SAT procedures
15	<>	SAT records

Table 1.1.1 List of Lloyd's related documents

The list of equipment/systems with a certificate or appraisal is stated in table below:

Item	Equipment/system	Certificate or approval/appraisal
1	IPMS	Certificate
2	IAS architecture	Approval
3	LPUs (per shipset)	Certificate
4	Ecdis	Type approval certificate
5	Navigation radar	Type approval certificate
6	Autopilot	Type approval certificate
7	Automatic Identification System	Type approval certificate
8	Fire Detection System	Type approval certificate
9	Fire Detection System (per sensor type)	Type approval certificate
10	FAT, HAT and SAT procedures/records	Appraisal

Table 1.1.2 List of Lloyd's Equipment Certificates/Approvals

1. Introduction

1.1 Purpose of this document

This document contains the overall system specification of the Integrated Automation System (IAS) of the TNI-AL project for the Indonesia Navy Corvette program, Tentara Nasional Indonesia Angkatan Laut. This specification is based on the requirements as described in the Technical Specification [1] and designed in according with Lloyd's Register of Shipping SSC 2003 under class notation:

✠ 100 A1 SCC MONO PATROL G5 LMC

The IAS offers a truly integrated solution for ship management, control and automation. For the Integrated Automation System, Imtech's UniMACS 3000 concept is used as basis.

1.2 Relationship to other documents

This document is part of the system design documentation for the Integrated Automation System [2]. It contains the overall design information for the IAS design. The IAS system design comprises the following documents and/or drawings:

- IAS System Specification [3];
- IPMS Functional Specification [4];
- IPMS Technical Specification HMI [5];
- IPMS Technical Specification ELP [6];
- PMS Functional Specification [7];
- PCS Functional Specification [8];
- Network Architecture CSN and PDN [9];
- Navigation System Interface Specification [10];
- IPMS List of Control and Monitoring signals [11];
- Item Survey [12];
- Dimensional drawings of the IPMS Consoles & Cabinets.

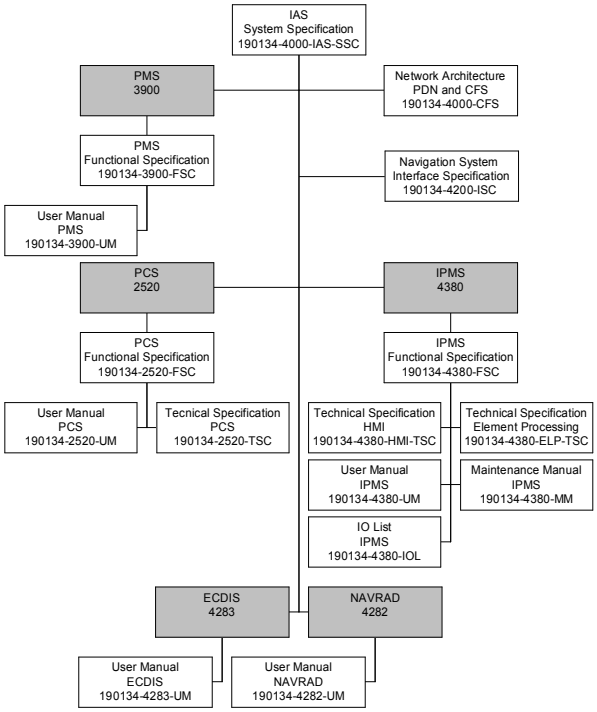


Figure 1.2.1 Automation documentation structure, TNI-AL IAS

2. System overview

2.1 General

This paragraph provides an overview of the primary functions of the IAS and the relationship between these functions.

The IAS system will be realized using COTS (Commercial Of The Shelf) hardware, software, and tooling.

The functionality of the IAS is realized with the following functions:

- Integrated Platform Management System (IPMS, section 3);
- Electronic Chart Display and Information System (ECDIS, section 4);
- Navigation Radar (NAVRAD, section 5);
- Automatic Identification system (AIS, section 6);
- Master Clock System (MCS, section 7);
- Power Management System (PMS, section 8);
- Propulsion Control System (PCS, section 9);
- Autopilot (AP, section 10);
- Closed Circuit TV System (CCTV, section 11);
- Fire Detection System (FDS, section 12);
- Infrastructure (INFRA, section 13).

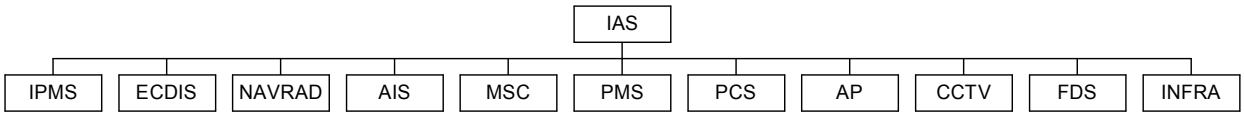


Figure 2.1.1 Automation functions of TNI-AL IAS

2.2 IAS functions

This paragraph gives a brief introduction of all the available functions realized within the IAS.

- Integrated Platform Management System (IPMS)
  The IPMS provides facilities to monitor and control the mechanical and electrical components in the vessel that are connected to I/O modules. The system supports measuring, presenting and (if applicable) pre-setting alarms of the various analogue and digital signals, logging the various signals and giving control commands.

- Electronic Chart Display and Information System (ECDIS)
  The ECDIS system displays selected information from a system electronic navigational chart with actual navigational sensor information from the Navigation System Interface Unit (NSIU) to assist the operator in route planning and route monitoring.

- Navigation Radar System (NAVRAD)
  Radar images are available on two (2) workstations. These workstations act as radar clients that connect to the radar server via the Client Server Network (CSN). The Navigation radar system provides the combat system

with target information.

- Automatic Identification System (AIS)
  The AIS supplies ECDIS and RADAR with via VHF transmission received positions of other ships in the neighbourhood also equipped with AIS. Transmission of own ships position can be prevented.

- Master Clock System (MCS)
  The master clock system is synchronised with the GPS UTC time. It is able to set the local time on a number of clocks throughout the ship.

- Power Management System (PMS)
  The Power Management System contains functions, which optimize the availability and reliability of the power supply. The electrical power supply system is responsible for the generation and distribution of energy at the required and specified voltage and frequency values.

- Propulsion Control System (PCS)
  The Propulsion Control System contains functions to monitor and control the propulsion related systems on board such as Main engines, Gearboxes and Controllable Pitch Propeller systems. The PCS has operator panels in the MCR and on the bridge.

- Autopilot (AP)
  The Steering Control System contains three levels of operations, Non follow-up, Closed loop and Autopilot. The Autopilot is a heading autopilot with a control and display unit located on the bridge from where the operator can adjust the heading of the ship. The autopilot is controlling the rudders by means of an analogue setpoint. Rolls Royce delivers the Steering Control System.

- Closed Circuit TV System (CCTV)
  The CCTV system provides safety and security Closed Circuit Television capabilities. The system consists of four (4) CCTV cameras, which are connected to the CSN. Via this CSN the camera images are distributed to the dedicated workstation CCTV on the bridge and the combined IPMS WS-AUX/CCTV in the MCR console.

- Fire Detection System (FDS)
  The FDS consists of various types of fire detection sensors in loops, connected to a Fire Detection Controller on the bridge. The FDS alarms will be displayed on the text display of the controller and on mimics of the IPMS workstations around the ship.

- Infrastructure (INFRA)
  Having the correct information available throughout the ship is getting more and more important. A reliable infrastructure of the IPMS is vital for achieving this requirement. This function monitors the healthy of the infrastructure, such as availability of network connections, availability of network nodes and status of running processes.

2.3 Relations between functions

The relationships between the IPMS functions in the different modes are described in the next paragraphs.

To / From	IPMS	ECDIS	NAVRAD	AIS	MCS	PMS	PCS	AP	CCTV	FDS	INFRA
IPMS		-	-	-	-	Platform Commands & Application Commands	Platform Commands & Application Commands	Platform Commands & Application Commands	-	-	-
ECDIS	-		-	-	-	-	-	-	-	-	General Application Alarm
NAVRAD	-	Targets & Radar overlay		-	-	-	-	-	-	-	-
AIS	-	Target Information	Target Information		-	-	-	-	-	-	-
MCS	-	-	-	-		-	-	-	-	-	-
PMS	Status of sensors & actuators Application status	-	-	-	-		-	-	-	-	-
PCS	Status of sensors & actuators Application status	-	-	-	-	-		-	-	-	-
AP	Status of sensors & actuators General Alarm	-	-	-	-	-	-		-	-	-
CCTV	-	-	-	-	-	-	-	-		-	-
FDS	FDS Alarms	-	-	-	-	-	-	-	-		-
INFRA	Status of IAS Equipment	-	-	-	-	-	-	-	-	-	

Table 2.3.1 Relationship between primary Functions

2.4 System architecture

2.4.1 The client–server architecture

The Workstations provide the Human-Machine-Interface for the applications. The processing and logging in a client-server concept is executed by the servers. The clients are optimised for HMI performance.

The redundancy in the IAS consists of the following levels:

- Redundancy by number, there are multiple workstations with the same functionality connected to the CSN network;
- Redundancy by number, there are redundant IPMS Servers;
- Workstations are equipped with a dual Ethernet interface;
- The Fibre optical network ring consists of a closed loop, each connection to the loop providing multiple transmission paths.

2.4.2 Servers

The client-server architecture of the IAS consists of the following servers:

- IPMS servers
  The configuration of the IPMS system is based on two redundant servers for the IPMS application software. For the distribution of I/O data (LPU) to the Clients, a redundant connection to the CSN is available.

- ECDIS servers
  The configuration of the ECDIS system is based on two servers for the ECDIS application software. These servers are redundant connected to the CSN. All navigational sensor information is derived from the NSIU through a serial interface to the server.

- Radar server
  The configuration of the radar server system is based on one radar server. The server is connected to the transceiver via a PCI board of the server workstation. Data from radar is continuously transmitted over the network and available to all radar clients running on the workstations.

- CCTV server
  The configuration of the CCTV system is based on a server for transmittal camera images via the CSN. The CCTV server support high quality Motion-JPEG. The transmitted image can be monitored from Two CCTV clients located at the bridge and in the MCR.

2.4.3 Clients

On the operator positions workstations are installed which act as client in the client-server architecture of the IAS. Each workstation has a double network connection.

2.4.4 Local Processing Units

The I/O interface with the sensors and actuators is realised via Local Processing Units that are equipped with a PLC rack. The PLC rack has the following standard components:

- Power supply
- Processor
- Network interface board to PDN
- I/O boards
    - Digital input 24 Vdc
    - Digital output Pot. Free contact
    - Analogue input 4-20 mA
    - Analogue output 4-20 mA

The LPU is designed to place a second optional IO rack. The IO boards in the second rack will be interfaced through the PDN to the processor

2.4.5 Networks

The IAS communication network on board is based on two redundant data communication networks. For details see System block diagram CSN and PDN [9].

- Client-Server Network (CSN)
  The CSN consists of a ring of fibre optic Gigabit Ethernet switches distributed over the ship to fulfil the requirements of redundancy, vulnerability and data concentrations. From these switches the data is routed to/from the workstations and servers with redundant 100Mbit/s Ethernet connections.
  The protocols used are complying with the open TCP/IP standards. This means that each network component, wherever placed in the ship, can make contact with any other network component on the CSN.

- Platform Data Network (PDN)
  The ControlNet IPMS network connects the IPMS servers to the LPU processors. The ControlNet network is a redundant state-of-the-art coaxial control network that meets the demands of real-time, high-throughput applications. The ControlNet network combines the functionality of an I/O network and a peer-to-peer network while providing high-speed performance for both functions.
  The ControlNet network offers deterministic, repeatable transfers of all mission-critical control data in addition to supporting transfers of non-time-critical data. The ControlNet network transfers scheduled data at 5 Mbit/s.

The exchange of data between the local area network (CSN) and Platform Data Network (PDN) is realised by the redundant IPMS Server.

2.4.6 Extension Alarm System

Alarm signalling columns will be provided, providing visual and audible alarm signalling. The columns will be mounted in the Main Engine Room Fwd and AFT. The alarm columns are fitted with 6 pictograms with dual faces and dual lights, with a rotating light on top of it and with an audio device. The following indication will be presented on the columns:

- General alarm
- Fire alarm
- Engine room alarm
- Emergency telegraph

- CO2 release alarm
- Telephone

2.4.7 Printer

The IAS provides one black and white laser printer. The printer is connected to the CSN via a single network interface to one of the network switches. The printer is located in the MCR

2.5 Function allocation to equipment

Category	Console / Area	Node	IPMS	PMS	PCS	ECDIS	NAVRAD	FDS	CCTV	INFRA
SERVER/CLIENT WORK STATIONS	BRIDGE NAVIGATION CONSOLE	IPMS Server + WS	S/C					R		AM
		ECDIS #2				S/C				
		Radar Client					C			AM
		CCTV							C	AM
	BRIDGE CHARTTABLE / PLANNINGSTATION	ECDIS #1				S/C				
		Radar server					S			AM SM
	OPS ROOM CONSOLE (delivery THALES)	Radar Client					C			AM
	MCR OPERATOR CONSOLE	IPMS Server + WS-ELEC	S/C					R		AM
		IPMS WS-PCS	C					R		AM
		IPMS WS-AUX	C					R	S/C	AM
PRINTER	MCR	PRINTER	D			D	D		D	
LOCAL PROCESSING UNITS	MER	LPU 01 PCS-PS	P		P					
	MER	LPU 02 PCS-SB	P		P					
	SWBRM AFT/MCR	LPU 03 AUX/MSB AFT/DG 3+4	P	P						
	SWBRM FWD	LPU 04 AUX/MSB FWD/DG 1+2	P	P						
	BRIDGE NAVIGATION CONSOLE	LPU 05 AUX	P							

Table 2.5.1 Allocation of IAS Functions to Equipment

Legend:

A = Alarm Display Function
AM = Application Manager (part of INFRA)
C = Client function
D = Data printing
P = Platform interface function
R = Repeater function of FDS
S = Server function
SM = System Manager (part of INFRA)

Note:
The Fire Detection System is treated as a platform system in abovementioned table.

2.6 Power distribution

The system for power distribution has a support function for all the IAS Components. The system for power distribution consist of two (2) mains-switchboards (MSB's) and each MSB is connected to two (2) diesel-generator sets, leads to four (4) diesel-generator sets in total for generating the ships power supply. The system also consists of one (1) ESB, which is connected to an emergency diesel-generator set. During normal operation the ESB is supplied from one of the MSB's. There are three UPS's connected to the ESB (Two can be manual switched over to one of the MSB's in case of the ESB is not recovering from a blackout). All main IAS components (supply from 230 VAC) are supplied from one of the UPS's. The IAS components with the same functionality are connected to different UPS's. The network switches are connected to three different UPS's. This means that the networks can support all data transmission even if one of the UPS's fails. The IPMS Local Processing Units are supplied from a 24 Vdc supply, which are connected to two different power sources. For an overview of the power distribution see Figure 2.6.1

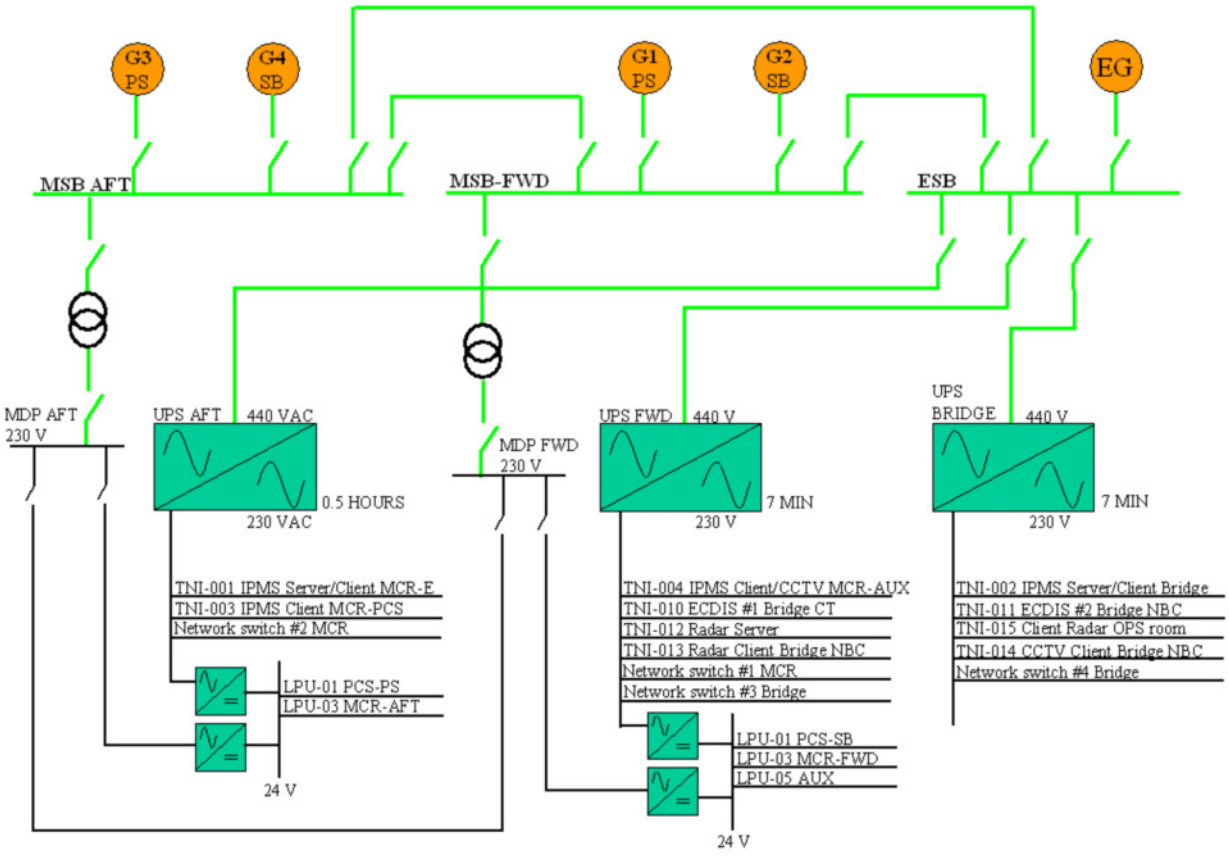


Figure 2.6.1 IAS Power Supply System overview

3. Integrated Platform Management System (IPMS)

3.1 System overview

The IAS function IPMS has a client-server architecture. The IPMS system consists of two workstations where a server application is installed and having a client function. In the MCR two extra workstations are placed with a client function. The two IPMS servers are connected with the Local Processing Units (LPU) via the PDN. The LPUs are processing data from the platform. Systems like main engines with a substantial numbers of data are connected to the LPU via a serial connection.

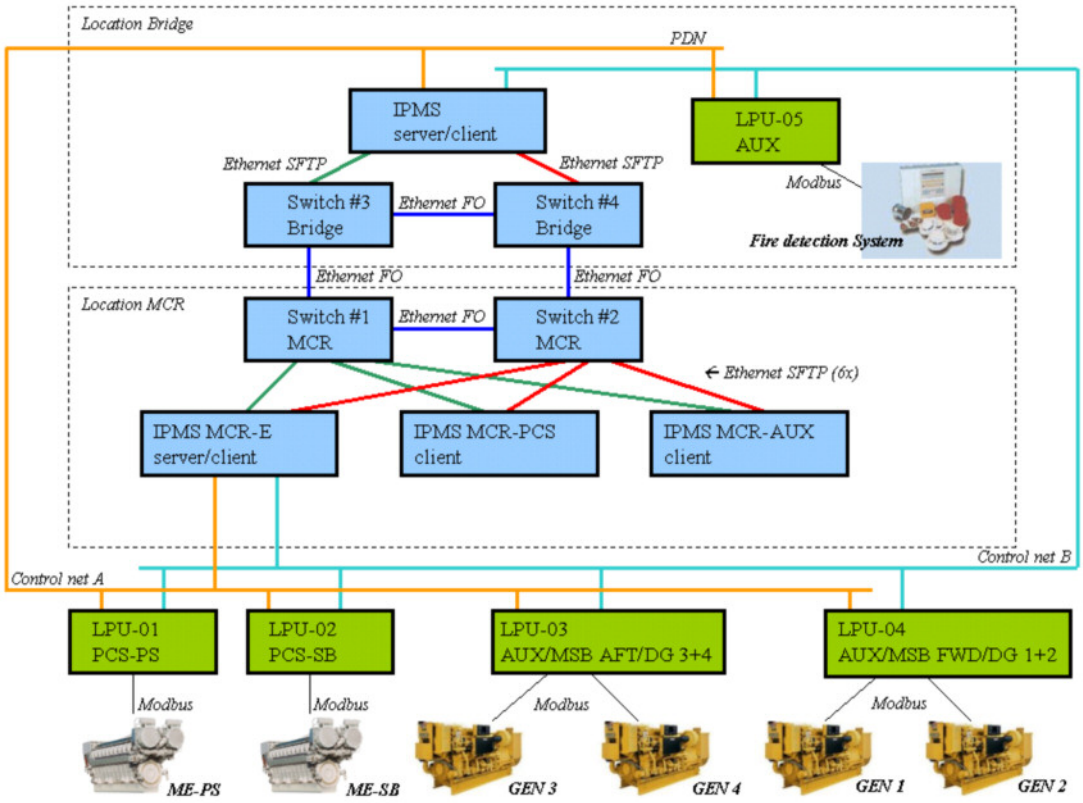


Figure 3.1.1 IPMS System overview

3.2 Functional description

The Integrated Platform Management system (IPMS) provides facilities to monitor and control the mechanical and electrical components in the vessel. The IPMS system architecture design is built on hierarchical operating levels of monitoring and control of the various platform systems:

- Supervisory control level (management facilities)
  Support facilities are provided for manipulating the configuration of the IPMS in terms of operator tasks, availability of components etc.

- Remote control and monitoring level (operators)
  The IPMS supports remote platform control from the MCR, Damage control station and Bridge;

- Local control and monitoring level
  The local control and monitoring level allows control of platform components mostly by means of control panels, overruling the operator commands given via the IPMS.

As highlighted above the IPMS covers the Supervisory control level (management facilities) and Remote control and monitoring level (Operators). Local control and monitoring level is no part of the IPMS configuration and is not taken into account in this specification.

3.3 IPMS Functions

The following functions are provided by the IPMS:

1. Element processing (ELP)
2. Platform Control and Monitoring (PCM)
3. Mimic Presentation (MIP)
4. Alarm presentation (ALP)
5. Function Allocation (FAC)
6. Signal trending (TRE)
7. Data Logging (DTL)
8. Health Monitoring (HMT)
9. Tank Monitoring System (TMS)

3.3.1 Element processing (ELP)

The function Element processing controls and monitors the platform systems. This is based on the data received from the I/O modules connected to the platform systems and operator commands.

3.3.2 Platform control and monitoring (PCM)

Operator stations with platform rights have the facility to control components of the assigned platform installations, refer to Function Allocation. Via the mimic presentation the operator can select the component he wants to control. When an operator has selected the component, the mimic will present dynamic information about that component in the Component Information window (CIP). This information, however, is not only displayed when the operator wants to control that component, but also when he wants to monitor the condition of that specific component.

3.3.3 Mimic presentation (MIP)

The system function mimic presentation provides schematic graphical overviews (max. 20 mimics) of the platform system. On a mimic the structure of a selected installation is presented. The representation of the platform components is dynamic and is updated as soon as the state of the platform components changes.

3.3.4 Alarm presentation (ALP)

The function Alarm presentation has the purpose to draw the operator's attention to the existence of undesirable situations by presenting alarm notifications.

3.3.5 Function allocation control (FAC)

The purpose of this system function is to support the correct division of the technical supervision (control and monitoring of installations) among the available operators. The platform components are grouped into a number of installations. Each platform component is allocated to one installation group only.

3.3.6 Signal trending (TRE)

To gain insight into the behaviour and the performance of platform components, it is possible to record, for a limited period of time and with a certain sampling rate, the values that are derived from the output signals of platform components, and to present the results of the recording in a graphical trend presentation. Trend presentation with up to 10 parameters is possible.

3.3.7 Data logger (DTL)

For the purpose of the technical monitoring of the installations on the ship, the condition of certain parts of the installation is recorded regularly: Important data will be gathered from IPMS during 72 hours.

3.3.8 Health monitoring (HMT)

The IPMS contains on-board diagnostic software to perform hardware diagnostics of the IPMS components. To support the 'repair by replacement' philosophy the software performs hardware diagnostics based on the level of exchangeable hardware modules (for instance individual I/O cards).

3.3.9 Tank Monitoring System (TMS)

The level measuring and alarm system serve to monitor and indicate the liquid supplies (fuels, oil, ballast water, fresh water, etc.). For tanks whose volume is not linear to the liquid level, tank-specific scaling parameter curves (liquid levels as a function of volume) shall be put into the IPMS.

3.4 External Interfaces

The IPMS supports interfaces with the following externals:

Description	LPU Connection	Type of protocol
Main engine PS	LPU-01 PCS-PS	Modbus
Main Engine SB	LPU-02 PCS-SB	Modbus
Gensys of generator 1	LPU 04 AUX/MSB FWD/DG 1+2	Modbus
Gensys of generator 2	LPU 04 AUX/MSB FWD/DG 1+2	Modbus
Gensys of generator 3	LPU 03 AUX/MSB AFT/DG 3+4	Modbus
Gensys of generator 2	LPU 03 AUX/MSB AFT/DG 3+4	Modbus
Fire Detection Controller	LPU-05 AUX	Modbus

Table 3.4.1 External Interfaces IPMS

The functional specification IPMS [4] has described above external interfaces in more detail.

4. Electronic Chart Display and Information System (ECDIS)

4.1 Functional description

The ECDIS displays selected information from an electronic navigational chart stored in the system together with navigational sensor information from the NSIU to assist the operator in route planning and route monitoring.

The hardware shall enable independent operation of both primary and back up ECDIS servers. The hard- and software of the backup ECDIS server shall be identical to that of the primary ECDIS server. The display of the ECDIS is directly connected to the server. One server is located in the navigation bridge console the other server in the chart table.

The two ECDIS servers are redundant and are able to operate autonomously in case of failure of one ECDIS server. One single point of data transfer will be used for the supply of data (chart data) to both servers. Therefore updating and initial installation of chart data will be limited to one action on the chart table ECDIS server. In case of a workstation Chartable ECDIS failure it is also possible to update chart data on the Navigation Bridge Console ECDIS server.

All real time and non real time navigation information as generated by the operator (or primary ECDIS server itself) on the primary ECDIS server are directly available at the backup system, and vice versa. In case of malfunctioning of the primary ECDIS server it is possible to continue safe navigation from the backup ECDIS server without delay and without loss of any functionality.

The Imtech ECDIS3500 has been certified according to IEC 61164 by Bureau Veritas.

4.1.1 Basic functions

The basic functions of the ECDIS comprises the following automation tasks:

- Presentation of Electronic Navigational Charts (ENC S57) Version 3.1 and higher if available
- Presentation of Admiralty Raster Chart System (ARCS)
- Automatic updated display of position and passed track;
- Route monitoring (anti-grounding and anti-collision warnings with different levels of alarms);
- Presentation of safety-contour;
- Presentation of ARPA targets;
  The information shall include target identifier number, target position, course, speed and CPA / TCPA on operator request. The ECDIS plot shows a scaled vector of course and speed and target identifier number. Display of ARPA information shall be in accordance with [S-52].
- Presentation of AIS targets;
- Computation of Great-Circle track;
- Presentation of cross-track error;
- Updating of ENC data;
- Position computation using manual (or ARPA retrieved) bearings and/or distances;

Since an ECDIS is a fully equivalent to the paper chart, the following functionality is implemented in the ECDIS, allowing full control of the navigational tasks:

- User addition of events, markers, symbols and text;
- Measuring of bearing and distances;
- Manual addition of temporary navigation objects;
- Validation of electronic navigation systems, using manual position fixing;
- Route-planning (ETA, speed, propulsion, etc.) and monitoring;
- Information retrieval of chart objects like buoys, cables, area's etc.;
- On-line object information with so called "Hooked Object Information", allowing on-line presentation of CPA, TCPA, range and bearing to various objects simultaneously.

Other ECDIS features are:

- Advanced Windows based human interface;
- Support for multiple dedicated user layers. User creation of symbols, text, lines and area's, guard zones;
- Total capability without paper chart back-up;
- Automatic best chart data selection;
- Route planning;
- Chart object information retrieval, including non-chart objects;
- Range and bearing measurements;
- Manual NtM input;
- ENC update facilities;
- Geographic warning tools (user layers editor);
- ARPA reference position;
- Import/Export functions for data distribution and exchange;
- Event recording;
- Voyage recording and replay (Black box function);
- Environmental light dependant colour schemes.
- Facilities for VRM (variable range marker), EBL (electronic bearing line) and construction lines (plotting of a visual bearing) and the ability to display a PI (Parallel Index line).
- Anchoring the constructions to a fixed point or to the current position of the vessel

4.1.1.1 Display Modes

The scale and the centre of an image shall be definable. Standard scales, including a default scale, shall be provided. The following display modes shall be operator selectable:

- True motion,
- Ship centred north-up,
- Ship centred head-up.

The ECDIS shall at least include the following functions to allow user to manipulate the chart image, this both in the planning and monitoring mode:

- Zoom in/out
- Move displayed area
- Change scale
- Chart Detail Selection
- ARPA Track Selection

- Own Ship Track
- Man over board function
- Chart next
- Mariners notes
- Routes
- Generate operator selected vectorised objects, safety lines and depth and contours from ARCS data.
- Route planning analysis tool

4.2 External Interfaces

There are two ECDIS servers onboard, both dedicatedly connected to the following equipment:

- NSIU: Navigation sensor information is received from the NSIU via one serial link containing all necessary sensor data like position, heading and speed.
- AIS: Positions of other vessels in the neighbourhood are received from the AIS via a dedicated serial link.

The designated targets on the NAVRAD are transferred via the network to both ECDIS servers.

4.3 Configuration of ECDIS

Next table presents an overview of the rights of each workstation.

WORKSTATION	Control	Monitoring
WORKSTATION IBS ECDIS	Yes	Yes
WORKSTATION CHARTTABLE	Yes	Yes

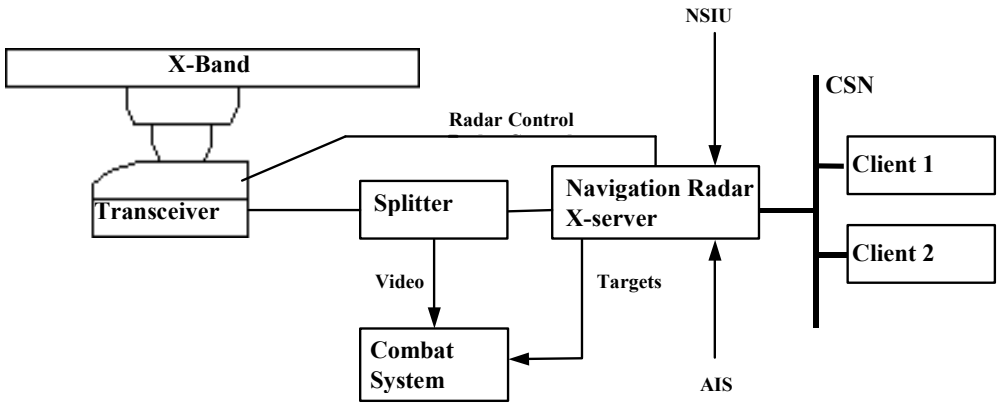
Table 4.3.1 Configuration settings ECDIS

5. Navigational radar system (NAVRAD)

5.1 Functional description

The Navigational Radar System consist of the following configuration:

- X-Band Radar antenna (Sperry 8 ft 25 kW, 9 GHz X-Band antenna up mast transceiver.)
- X-Band Server
- Radar Client Stations



The radar image video is transferred from the transceiver to the Navigation Radar X- server via a video splitter. The splitter creates from the input radar video two buffered outputs enabling both the navigation Radar X-Server and the combat system to simultaneously use the radar image video data. Control of the X-Band scanner and transceiver is however only possible from the Navigation Radar X-Server.

The NSIU supplies the necessary navigation data like ships heading, position and speed to the radar server. The radar server makes this data available on the CSN to be used by the radar clients. Furthermore the AIS is connected to the radar server. This enables the radar to show besides its own designated targets also target positions received via the AIS.

Radar clients
Data from the radar server is continuously transmitted over the CSN and is available to the Radar clients located in the bridge console and operations room (touch screen option), as defined in Table 2.5.1 Allocation of IAS Functions to Equipment.

All necessary data to display radar images on the related clients is made available on the CSN by the Navigation Radar Server (NRS). Therefore the NRS client is a software application that runs on the related workstation with access to the CSN. Next figure is a screen dump of the display of the NRS client application. The HMI is made for Windows point and click operation, using a mouse or other pointing device as a tool. Furthermore the HMI is designed in such a way that it is fully usable on a touch screen where all input is handled via the touch screen. The NRS client in combination with the NRS server fulfils the IMO requirements for ARPA radar and has been certified by Bureau Veritas.

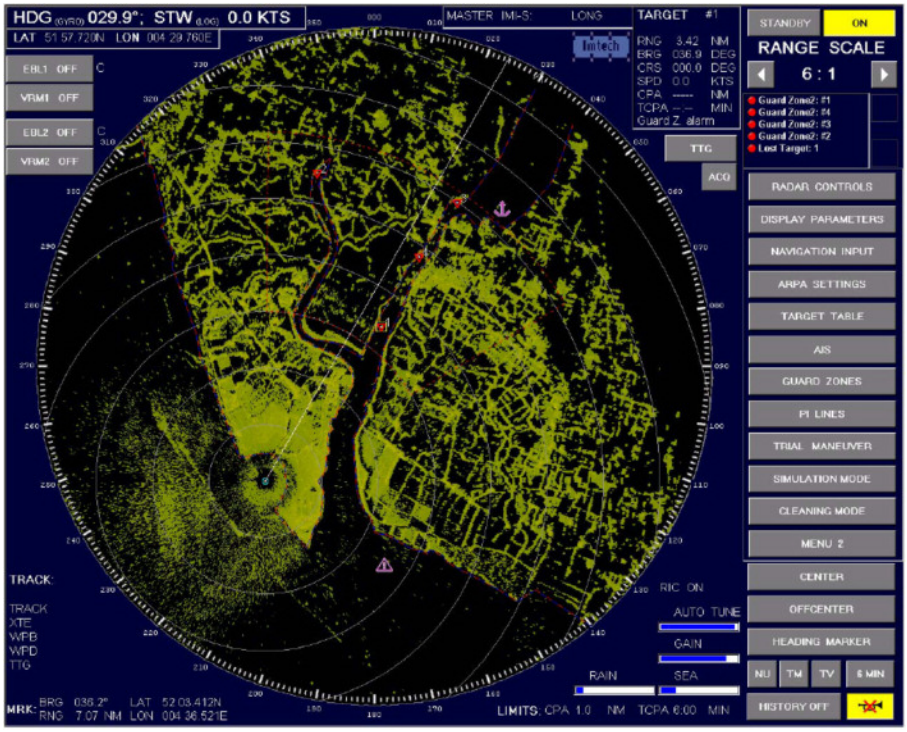


Figure 5.1.1 Radar client

The NRS client takes care of the following functions:

- Radar man machine interface;
- Conversion from radar data to bitmap (scan-conversion);
- Display and control of the Automatic Radar Plotting Aids (ARPA) tracks;

Any operation related to the display of the radar data like settings the display range, history length, after glow, heading up, north up, etc. does not interfere with other Radar clients. Each Radar client may set e.g. a different display range. Only the commands related to the transceiver and/or scanner like settings or changing power, pulse length, guard limit & target acquiring etc., interfere with the other clients.

5.2 Detail Functionality

The table hereafter gives an overview of the functionality of the radar client workstation.

Available functionality
ranges: 0.25, 0.5, 0.75, 1.5, 3 , 6, 12, 24, 48 and 96 NM
variable range marker / electronic bearing line, dual (VRM/EBL)
parallel index, dual (PI)
trial manoeuvre (T)
presentation options: - north up - head up - course up - relative motion - true motion - off centre
vectors relative / true
vector length
manual acquiring of up to 40 targets
guardzone acquiring of up to 200 targets
alarm limits
display options, etc.
stabilisation options: - north up, stabilised - course up, stabilised - head up, unstabilised
history / past track / afterglow
day / night view
data link to ECDIS through CSN
performance monitoring
the possibility to give a target a name instead of an automatically generated number (the names are stored in the server's database, available to all clients)
selection of up to 4 different RADAR sources at one station
selection of network-available sensor-data (navigational sensor input)
defining area's in which ARPA targets are not shown
simulation options for familiarising with the RADAR installation
controls gain, tune, rain clutter and sea clutter can be operated automatically, for an optimal view
ground stabilised: - fixed on target - GPS stabilised

Table 5.2.1 Detail functions Navigational Radar

6. Automatic Identification System (AIS)

6.1 Functional Description

The AIS is a broadcast Transponder system, operating in the VHF maritime mobile Band. It is capable of sending ship information such as identification, position, course, speed and more, to other ships and to shore. It can handle multiple reports at rapid update rates and uses SOTDMA technology to meet these high broadcast rates and ensure reliable and robust ship-to-ship operation.

The AIS receives position reports from other ships in the neighborhood that are within VHF range. The AIS is equipped with a small display that allows the system to display the information form these ships like position, intentions and size. The system is interfaced to the NAVRAD and ECDIS where the positions of the received AIS targets will be visualized on the presented chart and on the radar image. This integration of information enables the navigator to get a quick image of the surrounding traffic in relation to the chart.

The AIS is fitted with a combined GPS/VHF antenna. The transmission of own ships position and other data can be silenced via a key switch mounted on the navigation bridge console. This is a feature only implemented and available on Naval vessels for obvious reasons. There will be no VHF transmissions anymore by the AIS when it is placed in silence mode. However it will still be able to receive AIS messages from other ships.

6.2 Technical Features

- SOLAS High Sea Class A Transponder Unit
- Wheelmark Type Approved
- All functions integrated into one single unit
- Integrated VHF transmitter
- Integrated GPS receiver for time synchronization
- Combined GPS/VHF antenna
- Integrated display and keyboard
- Naval version with ability to silence transmission so called “Silent Mode”

The fully alphanumeric keyboard is combined with a simple, easy to operate menu navigation. The self-explanatory menu ensures that the user quickly becomes accustomed to the system.

6.3 External interfaces

The AIS 3500 has two external interfaces:

- The AIS is interfaced to the DGPS to get the precise position of the vessel, and to the gyro to get the current heading.
- The AIS system has a serial interface to the navigation radar server for sending the positions of the received AIS targets. The navigation radar server is transmitting the collected data over the CSN network to the radar clients and the two ECDIS servers.

The more detailed description of this external interface can be found in the Navigation System Interface Specification [10].

6.4 Safety Functions

The AIS 3500 is fitted with Safety Keys, which allow the user to automatically send urgent messages without the necessity of navigating the transponder menus. The SRM Button sends out Broadcast Safety Related Messages to all ships within receiving range. The MOB Button automatically saves the precise position coordinates of where the incident occurred, and automatically generates an alert message, which is sent out to all neighboring AIS equipped vessels.

7. Master Clock System (MCS)

7.1 Functional description

The ship will be equipped with a master clock system consisting of a master clock unit and several clocks placed throughout the ship. All clocks are connected to and are driven by the master clock unit. The master clock unit allows the operator to set the ship time or local time zone. After setting the new time by the operator all clocks will start to synchronise to the new time automatically.

Figure 7.1.1 Picture of master clock unit

7.2 Configuration of clocks

In this projects two type of clocks are used. A digital clock is placed on the bridge. For all other spaces in the ship where a time indication is required a standard analogue clock is placed.

7.2.1 Analogue clocks

The master clock system consist of a number of analogue clocks with the following specifications:

- Hour – minutes – second movement
- Clock diameter: 320 mm
- Case colour: White case
- Dial colour: White with black figures

Figure 7.2.1 Bitmap of analogue clock

The analogue clocks are placed at the following locations:

- 4052 Operations Room
- 4042 Commanding Officer
- 3052 Ward Room
- 3064 Office
- 3102 JR Mess Room
- 3105 Medical Treatment Room
- 3105 Medical Treatment Room
- 3084 MCR
- 3112 LPO + PO Mess Room

7.2.2 Digital clock

On the bridge a digital clock is placed with the following specifications:

- Hour – minutes – second display
- Figure height 5 cm – readability: 20 meters
- Dimensions: 362 x 106 x 77 mm
- Diode colour: red

The digital clock can be dimmed by means of two push buttons on the backside of the clock.

Figure 7.2.2 Bitmap of digital clock unit

7.3 External interfaces

The master clock system is synchronised via the GPS. To enable this a serial link between DGPS and master clock unit has been established. The more detailed description of this external interface can be found in the Navigation System Interface Specification [10].

8. Power Management System (PMS)

8.1 Functional description

Power Management is a stand-alone system, integrated within the platform monitoring system dedicated for full automation of ships power plant and guarantees the availability of power in the most efficient way. The power management system is based on the GENSYS generator management system. The system for power distribution in this case consists of two (2) mains-switchboards (MSB's) and each MSB is connected to two (2) diesel-generator sets, leads to four (4) diesel-generator sets in total for generating the ships power supply. Every diesel-generator set is equipped with it's own GENSYS generator management module located on the MSB for optimum control of energy distribution aboard. The Power Management System features a manual mode and an automatic mode. This is achieved by:

- Starting and stopping the generators
- Loading and unloading the generators
- Synchronising and load sharing of the generators
- Synchronising the bus bars
- Synchronising to shore
- Monitoring the power, current, voltage and frequency of generators
- Activation of the automatic disconnection of non essential consumers

In manual mode, the power management system can be controlled manually from the GENSYS control panel located on the MSB. In automatic mode a forced start of a generator can be executed from the main switchboard in order to get and keep generators online independent of the load.

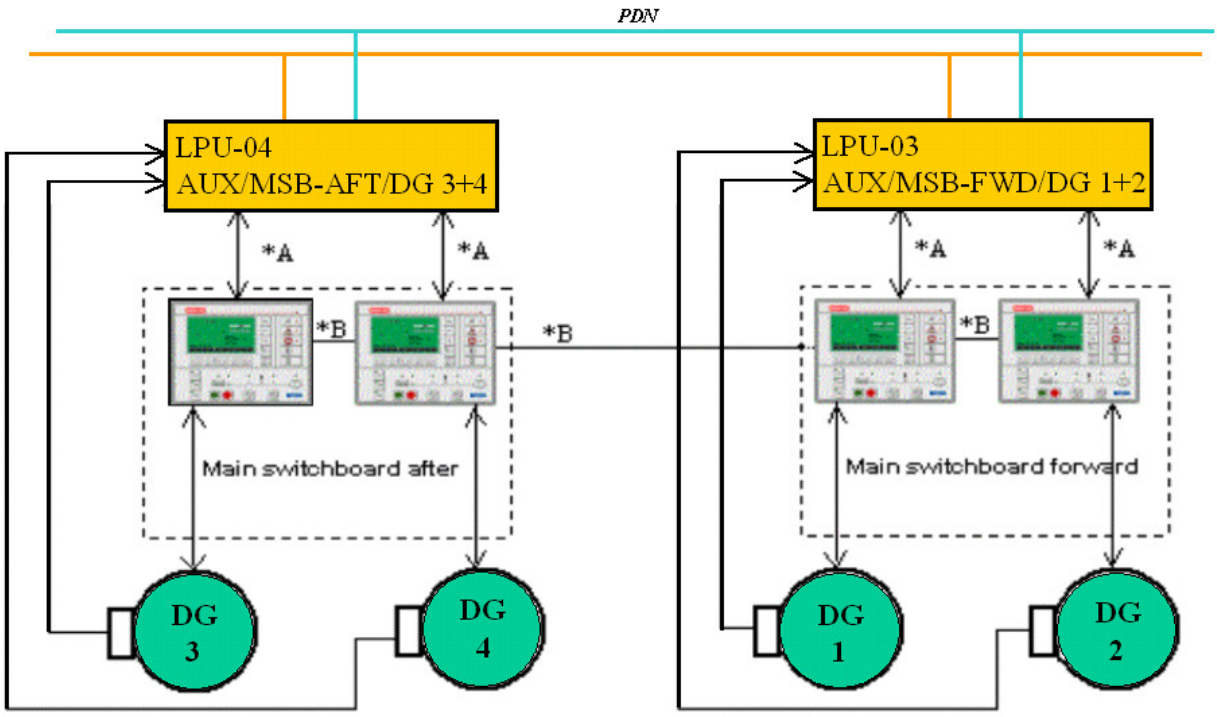


Figure 8.1.1 Block diagram of the Power Management System

8.2 External interfaces

The power management systems is integrated via MODBUS with the PDN for communication with the HMI. The drawing below shows the communication between the GENSYS, LPU and HMI. The more detailed description of this external interface can be found in the Power Management System Functional Specification [7].

9. Propulsion Control System (PCS)

9.1 Functional Description

The PCS shall be responsible for the monitoring and control of the propulsion machinery configuration.
The PCS consists of one local controller for each shaft and can operate independent from the rest of the IPMS. The PCS will contain the following functions:

- Control mode selection
- Control position transfer
- Propulsion configuration selection
- Starting/stopping engines
- Overload protection

9.1.1 Control Mode Selection

The control modes manual and automatic mode are supported by the PCS.
Manual mode is selected automatically when the propulsion sub-systems are not available for the PCS anymore.

9.1.2 Control Position Transfer

There are two control panels/positions available for the PCS, one on the Bridge and one in the MCR location. Propulsion control is restricted to only one control position at the time. Transfer of control position is done by means of an acknowledgement procedure. This means that transfer of control is to be requested at the new control position. The operator in control has to acknowledge this request. As long as no response is given to the request, the right of propulsion control remains with the operator in control.

9.1.3 Propulsion Configuration Selection

The PCS makes use of a propulsion configuration allowing the usage of two Diesel Engines. Several propulsion configurations are available such as PS/SB driven, SB/PS trailing mode and Cruising mode. Selection of the appropriate mode can be done via a propulsion control panel. Control of the applicable clutches is done automatically, depending of the required propulsion configuration.

9.1.4 Starting/Stopping Engines

The PCS provides the control for starting and stopping of the engines. A ready indication is shown if the starting conditions are met. The starting conditions are displayed on the Propulsion Control System mimics page of the IPMS. Stopping of the engines is performed including a defined cool down period of the engine. Both starting and stopping can be done on the local control panel located in the MER or via the propulsion control panel in the MCR.

9.1.5 Overload protection

When the (diesel) engine is overloaded by the CPP, the PCS will decrease the pitch of the CPP. Decreasing of the CPP pitch will result in a lower demand load of the engine(s) and prevent overloading of engines.

9.2 PCS architecture

The PCS provides automation functionality combining the operation of the individual propulsion system components into one integrated Propulsion System. Each propulsion system component has its own local controller providing monitoring and control interfaces and component protection functionality.

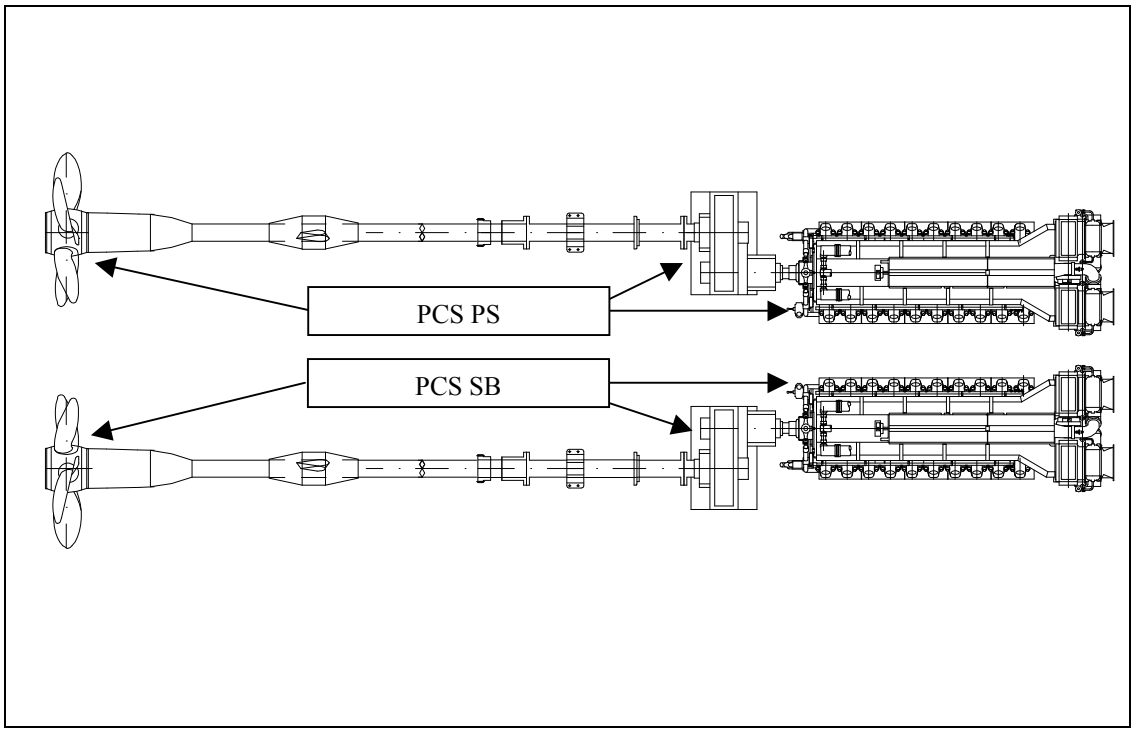


Figure 9.2.1 Overview of the Propulsion Control System

9.3 External interfaces.

The PCS will exchange data with the following platform systems:

- Gearbox Systems (Clutches, and shaft-brakes)
- Diesel Engines
- Controllable Pitch Propellers

9.4 Propulsion system indications

The main analogue indications of the PCS like ME Speed, Shaft speed and CPP pitch are presented on several locations through the ship.

- Bridge Navigation Console (ME Speed, Shaft speed and CPP pitch)
- Bridge overhead Panel (ME Speed, Shaft speed and CPP pitch)
- Bridge Wings panels (Shaft speed and CPP pitch)
- Switchboard room-aft/MCR/DCHQ (ME Speed, Shaft speed and CPP pitch)

10. Autopilot (AP)

10.1 General

The Steering Control system is responsible for the control and monitoring of the two rudders. In the steering system three levels of operation are available:

- NFU: steering by means of push buttons
- FU: steering by means of tillers
- AUTO: Autopilot (synchronous)

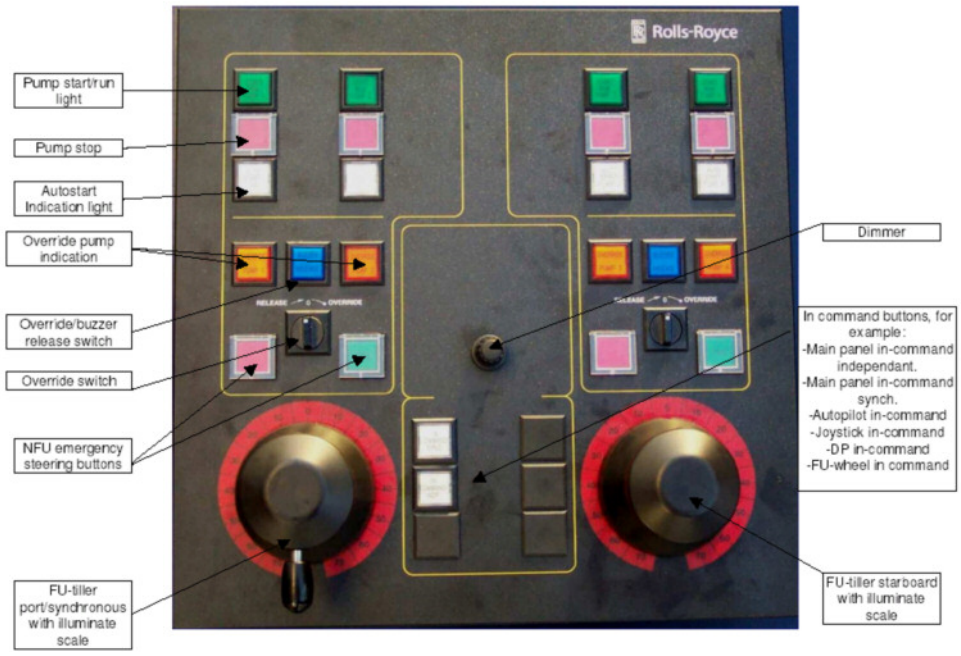


Figure 10.1.1 Main Control Panel steering gear system

The detailed description of this panel can be found in the system description of Rolls Royce.

10.1.1 Non Follow-Up Emergency steering

In this mode the steering can be done by push buttons on the Main Control Panel on the bridge. In Non Follow-Up mode rudders are controlled independently.

10.1.2 Follow-Up steering

In this mode the two available tillers on the Main Control Panel can do the steering of the ship. The Follow-up steering mode can be used in either synchronous or asynchronous control of the rudders. By means of a push button on the Main Control Panel synchronous or asynchronous control can be selected. In synchronous control the PS tiller controls both the rudders. The detailed description of the NFU and FU mode can be found in the system description of Rolls Royce

10.1.3 Auto mode; Autopilot (AP)

In this mode the autopilot controls the rudders. The autopilot is keeping the ship on the selected heading by means of an analogue setpoint interfaced to the steering control system.

10.2 Functional description

The NAVIPILOT V HSC / G is a type-approved autopilot designed for applications on all type of vessels. The autopilot accepts a gyrocompass heading input. The autopilot control unit includes a liquid crystal display, which permanently indicates all information required by contemporary navigation demands:

- Current Heading
- Set heading (course to steer)
- Rudder angle
- Steering mode (AUTO/MAN/NAV)

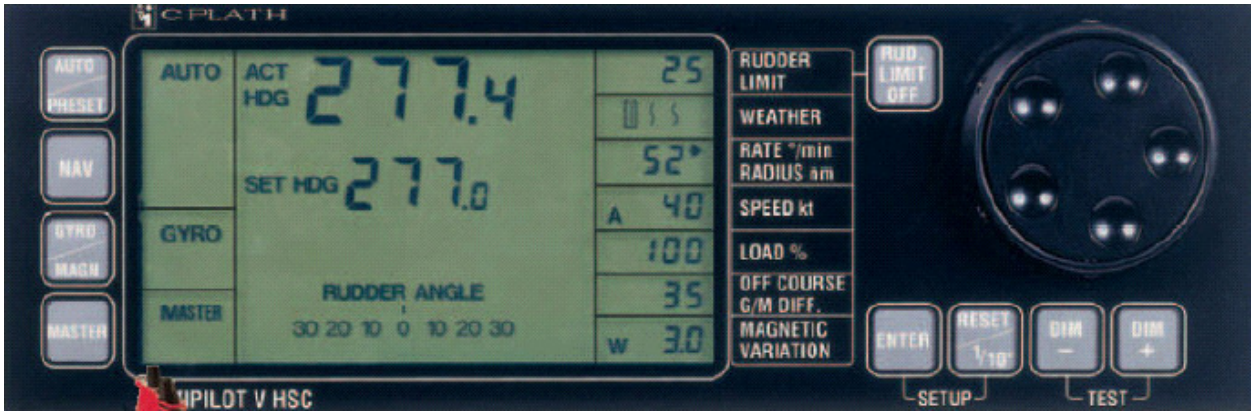


Figure 10.2.1 Bitmap of Autopilot control panel

10.2.1.1 Technical features

- Gyrocompass heading interfaces: RS422, 6 steps/°, synchro 1:360
- Speed interface: NMEA 0183 or 200 pulses per nautical mile.
- Analogue output for rudder control.
- NAV interface with 9 unidirectional and 7 bidirectional protocols.
- Direct selection of the operator setup procedure.
- Service setup protected by coded access.
- Operational data remain stored during power failure.
- Clear error indication and identification.
- Display and control illuminated by electroluminescent foil.
- Analogue selection of set heading and all other major parameters.

10.3 Rudder indications

The rudder angles are indicated on several locations through the ship.

- Bridge Navigation Console
- Bridge overhead Panel
- Bridge Wings panels (PS and SB; Bulkhead mounting)
- Switchboard room-aft/MCR/DCHQ
- Operation Room (Bulkhead mounting)
- CO accommodation (Bulkhead mounting)
- Locally (mechanical on steering gear)

11. Closed Circuit Television (CCTV)

11.1 Functional description

The CCTV system consists of fixed wide angle CCTV cameras, which are connected via CCTV server to the CSN (Client Server Network). The cameras are allocated in the Main Engine Room (3) and the Flight deck (1). The Camera on the flight deck is equipped with a wash/wipe installation, which can be controlled from both the MCR and the Bridge. The camera images are transmitted via the CSN to the various workstations as defined in Table 2.5.1.

The CCTV system provides the following functions:

Camera image (de) compression:
This function of the CCTV server takes care of compressing the camera images, in order to limit bandwidth use of the CSN. When a camera image is shown on a workstation, the workstation will de-compress the camera image in order to display it in the original format.

Camera image distribution:
This function takes care of making every camera image available on a workstation. The operator can select up to four cameras in one time to view. The name and the zone of the selected camera are shown in the header of the camera window. When the direct video image of a selected camera is shown, a camera-symbol is shown in the camera window.

Image specifications:
Compressed according to the MJPEG standard;
Max. image resolution: 352 x 288.

12. Fire Detection System (FDS)

12.1 General

The Fire Detection System detects and collects information from various types of fire/smoke fire detectors, which are arranged in loops and connected to a Fire Detection Controller on the Bridge.

The following sensors will be provided and allocated:

- … optical smoke detectors;
- … heat detectors;
- … manual call point;
- … line isolator;
- … zener barrier;
- One (1) timer module for the workshop.

TBD 12.1-1 Number of provided fire detection sensors

The Fire Detection Controller has the following typical functions and features:

- Collects the information from the sensors, which are arranged in loops;
- Activation of audible and visual alarms on the FDC, which is integrated in the CT console;
- An interface with an IPMS LPU, transferring the FDS information to the IPMS servers. When this interface is failing, the operator will be notified by an alarm on the IPMS alarm page. The FDS remains operating.
- An LCD display showing the fire detectors in alarm. This display makes the FDS functioning completely independent from the IPMS;
- 115Vac power supply;
- 4 detector loop modules with a maximum of 99 addresses;
- A defective fire detector will not block other fire detectors in the same loop.
- A maximum of eighty (80) zones with a total of nine hundred ninety (990) addresses.

Alarm acknowledgement on fire detection controller and IPMS work independently

13. Infrastructure (INFRA)

13.1 System Manager

The System Manager offers System Console functionality. Error messages regarding functioning of workstation applications are relayed to the System Manager. Status data can be viewed according to the following tree structure:

- Ship's area (e.g. Bridge or Machinery space);
  - Consoles located in different area's;
    - Clients and Servers Workstations build in consoles;
      - Applications running on Client and Server Workstations.

Both Servers and Clients can be controlled using the System Manager. The System Manager works closely together with the Application Manager.

The System Manager offers the following functionality:
- Logging of system events of connected workstations.

The operator interface offers a tree structure showing status information of the following system elements:
- Workspaces subdivided in Ship Areas, Consoles, Workstations and Applications
- Network Neighbourhood subdivided in Network Switches and Network Interface Cards (NICs) in Workstations.

13.2 Application manager

The Application Manager is a tool to select applications running on the workstation. By clicking on an icon representing an application displayed on the Application Manager's Toolbar, the selected program will get the focus of the Windows operating system and moves to the foreground to be viewed and controlled.

Besides selection of applications, the Application Manager offers the following additional functionality:
- Guarding error free execution of executables by the Windows Operating system;
- Providing print screen facilities to the selected printer;

Blocking of certain keyboard input like <ALT><F4>;
Guarding the redundant Ethernet connection of the workstation to the Client-Server Network.

13.3 Operating System

The Operating System for this project will be Microsoft Windows 2000.