

# Software Loading and Testing Facility for DMC

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**Abstract:** Advance Light Helicopter (ALH) designed and developed by Hindustan Aeronautics Limited, is fitted with various Navigational and Avionics systems. In the Glass cockpit configuration of ALH, four critical units viz. CDS, DIU, MFD & DMC are integrated and play a major role in aiding the flight navigation. At present the Display and Mission Computer (DMC) software is loaded by manual interaction. Also the Digital Moving Map is loaded through manual interaction only. It involves a dedicated technician to spend more than 4 hours during the operation. This project is intended for making the process of software loading and Moving map loading in the DMC, automatic. This automation will result in avoiding the presence of the technician for doing the operation manually and it also reduces the operating time. Once, the applicable software is loaded and the required Digital Moving Map is also loaded through this automation set-up, the operation of this DMC can be checked. It can be done only if it is interconnected with the other modules viz. CDS, DIU and MFD. Hence hardware has been developed to interconnect all the units for simulating the Helicopter environment.

**Keywords:** mission computer, software loading, DMC, map loading, helicopter

## 1. Introduction

### 1.1 Integrated Architecture and Display System (IADS)

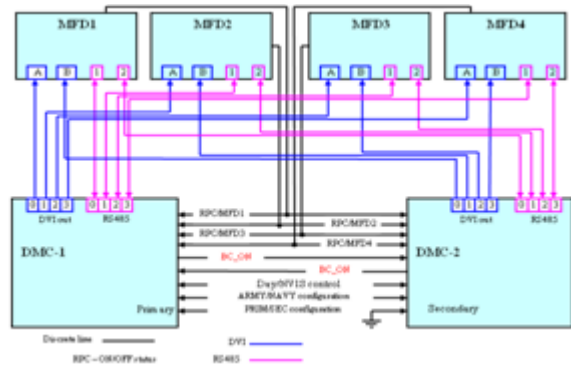
The Integrated Architecture and Display System (IADS) replace the conventional Cockpit on the helicopter. The main components of the integrated architecture and display system are display and mission computer (DMC), control and display system (CDS), multifunction display (MFD) and data interface unit (DIU).

One of the critical units in IADS is the display and mission computer (DMC) which acquires data from the sensors on the helicopter. The data is acquired both in digital as well as analog form and is displayed on the MFD and CDU. There are four modifications in an ALH helicopter. They are MK I, MK II, MK III and MK IV. MK I has the analog setup in the cockpit which does not provide accurate navigation and flight details. So we have gone for a better configuration by making the whole setup of the cockpit digital. Thus from MK II onwards it is fully digitized and has the glass cockpit. Further enhancement has been done by adding weapons in the MK IV helicopters. Our project can be used from MK II, MK III and MKIV. IADS also gives outputs to various helicopter systems in the required format.

### 1.2 IADS Architecture

The IADS architecture is redundant and comprises the following Components:

- Two Display and Mission Computers (DMC) located in the nose cone,
- Two Data Interface Units (DIU) have been placed in the cabin aft
- Two Control and Display Systems (CDS) located in the center console and
- Four Multi Function Displays (MFD) located on the main instrument panel.
- The IADS block diagram for army utility configuration is provided in the following figure.



### IADS switching on procedure

**Electrical controls:** The electrical control for the IADS consists of the Circuit Breakers for powering of each LRU of IADS and switches.

**DMC:** DMC1 is switched on when DMC1 CB is pushed in. DMC2 is powered on when DMC2 CB is pushed in.

**DIU:** The DIUs are powered by DIU1 PWR, DIU1 CONT, IADS CONT CB (for DIU1) and DIU2 PWR, DIU2 CONT CB (for DIU2). However, the DIUs are switched on when the IADS1 and IADS switches are switched ON.

**MFD:** The MFDs are powered by MFD1, MFD2, MFD3 and MFD4 CBs respectively. However, the MFDs switch on when the IADS1 and IADS2 switches are switched ON. The MFDs also have individual ON/OFF control rocker on the right bottom row of MFD bezel for switching on and off the MFDs.

**CDU:** The CDUs are powered by CDS1 and CDS2 CBs. When IADS1 and 2 are switched ON, automatically CDU turns ON.

### Sequence of operation of IADS:

The IADS system is switched on in the following sequence:

- Switch on the DC power to the helicopter as per normal sequence as given below:

Connect external power plug to EPR  
 Put OP MOD SEL switch to AUTO  
 Put PWR SEL switch to EXT  
 Push in External power CB located near the EPR  
 Put MASTER POWER switch to ON  
 Push in CBs DC SYS1 and DC SYS2.

### b) Switching on IADS system

Push in the following CBs on OH panel: DMC1 and DMC2, DIU1 PWR, DIU1 CONT, IADS CONT, DIU2 PWR, DIU2 CONT, CDS1, CDS2, MFD1, MFD2, MFD3 and MFD4. The system takes some time for initialization (for completing the self test / Built-in Test (BIT)) the system goes through power on self test (Built-in-Test - (BIT)) as soon as the DMCs are powered. The BIT takes about one minute.

### Warning philosophy in IADS

Whenever a caution/ warning are triggered the following will occur: Master Warning light will flash

- The relevant system head group caption is flashed on the ADI displayed on the PFD
- Relevant warning/ caution caption is displayed on SYS page in the respective warning window (right window for RH common systems, left window for the LH systems on the helicopter).

## 2. Literature Survey

K. Engel in his paper "The Advanced Mission Computer and Display system for naval aviation" explains about the new displays which will feature commercial high-resolution color digital displays modified for the military environment. An added feature to this system was the data bus. This upgrade brings a Fibre Channel network running on fiber-optic media to the F/A-18E/F. another important feature was creation of a mission computer that could be handled in a software environment which reduces the cost of maintenance for the software.

Y. Zhuangyuan and W. Jiangyun, in their paper, "Research and implementation of display system in an avionics integrated simulation system," discuss the design and realization of the display system in an avionics integrated simulation system. There are probably very few differences between an integrated display system and other subsystems in avionics. On deep analysis we could learn that the flight information has to be displayed in integrated display system.

B. Sutterfield, J. A. Hoschette and P. Anton, presented a paper, "Future integrated modular avionics for jet fighter mission computers," explains the need for highly flexible and versatile computing architectures to meet the ever-changing jet fighter aircraft mission needs with cost-effective processors. Dense multiplexing busses (optical technology) are required for interconnecting multi-core modular processors. Multi-level security will be required to provide safeguards to ensure the integrity of the network. Systems must have a structure that supports open standards but still allows ultra high density packaging. Backplanes consist of integration of electrical and optical signals, and the growth in modular software development and legacy software reuse is necessary to maximize the efficiency for

building a new hardware. All technologies existing today can be combined to provide a quantum increase in processing capability. It then becomes highly reliable with affordable costs.

R. Farmer, "The mission computer/electronic display subsystem for the C-17A avionics suite," explains the cockpit display and mission planning functions of the C-17A which is provided with the mission computer/electronics display subsystem (MC/EDS). The MC/EDS consists of 15 individual components. There are four multifunction display (MFD) units installed in the primary cockpit instrument display area. The center console contains two multifunction display controllers (MFC), two mission/communication keyboards (MCKs), and four mission/communications display (MCD) units. Three Delco Magic V Mission computers are installed in the electronics bay at the rear of the cockpit. The equipment has been designed to support aircraft operation by a flight crew of two, and the cockpit reflects mission thinking.

J. W. Dickerson, explains in the paper "ATE and Avionics Display Systems," that sophisticated avionics display systems are rapidly replacing the multitude of indicating panel meters and CRT displays of the past. As the avionics display system is becoming sophisticated there surely exists a requirement to improve the testing techniques for the display. This paper addresses the types of systems to be tested in addition to past and present testing methods.

G. Sinaki, in the paper "C-17A mission computer internal built-in test and I-level fault logging," describes the C-17A mission computer (MC) internal built-in test (BIT) and intermediate level (I-Level) fault logging strategies. The MC/EDS is intended to provide flight management functions for the C-17A aircraft in addition to display processing and display of mission, flight, engine, aircraft status and other related information to the flight crew. The mission computer has been designed so that it is highly reliable. The subsystem uses triple modular redundancy and voting techniques which detects the failure and isolates the unit with line replaceable unit (LRU). The fault detection circuits in the MC detect the faults concurrently with the normal operation and report them to the MC CPU. The self-test program comprises of separately executing software/firmware modules. A high degree of fault detection coverage is achieved by combining these modules with the BIT hardware.

## 3. Hardware Implementation

### Display and Mission Computer (DMC):

A DMC is a multi-role, real-time airborne central processing unit for avionics applications. It provides the core for avionics management, mission processing and display functions. The DMC system is a highly integrated system providing high performance and multi I/O -digital, analog, and video interfaces integrated in a single enclosure. It is designed as a single processor system based on Aitech's C106 SBC. All system resources are mapped to this processor and are peripherals to it. Two DMC systems are installed in an aircraft, each performing its assigned functions, and each is capable of performing the functions of the other in case of malfunction (redundancy).

**USB Port Description**

The DMC includes a USB port; ISP1561 model of the USB PCI Host Controller manufactured by Philips that uses the USB connectivity of the DMC system. The USB PCI Controller integrates in it four USB downstream ports, two of which are used in the SBC. The two ports provide USB specification support and backward compatibility with USB 1.1. The USB controller integrates three separate independent controllers: two Open Host Controller Interface (OHCI) controllers and one Enhanced Host Controller Interface (EHCI). Each downstream port can be routed to one of the OHCI cores or to the EHCI core. The USB controller integrates in it a DMA engine and FIFO buffers to support high data transfer between the controller and system memory over the PCI bus. The USB PCI Host Controller is located on the SBC local PCI bus and mapped into PCI system memory space through software. The USB PCI Host Controller has a single interrupt line (INTA#) routed to the SBC secondary interrupt controller.

**MIL BUS 1553:**

The DMC includes a dual MIL-STD-1553B facility. MIL-STD-1553B is implemented by a component of PCI MicroACE MIL-STD-1553B controller (model BU-65864B3) manufactured by Data Device Corporation (DDC). The PCI MicroACE uses the MIL-STD-1553B interface of the DMC system. Two of these interfaces are available in the system; each includes its own dedicated controller.

**RS-232/422/485:**

The DMC system provides ten serial communication ports. Nine of the ports are standard UART ports (supporting the RS-232/422/485 interface) and one is a non-standard avionics RS-232 UART which is located in the IOM. All standard UART controllers are located on the SBC and divided between two serial communication controllers.

Two ports are used through the Multi Protocol Serial Controller (MPSC) integrated in the Discovery™ system controller. Seven of the remaining ports are used through the Enhanced Serial Communication Controller (ESCC), model SAF82538 manufactured by Siemens.

The non-standard avionics RS-232 (within the IOM board) is converted into a standard RS-232 physical layer and drives it to the SBC.

**Multifunction Display**

The Multi Function Display is the main terminal display system of the helicopter's flight and navigation computer. Each helicopter includes four 10.4" MFD units through which the operator can display flight data on software indicators, navigation data on digital map, real time video and any other application defined by the central computer. The MFD provides setting and update of data and interfacing with two Mission and display processors (DMC) via RS-485 full duplex serial links. The MFD receives digital video signals from DMC and displays it according to the computer's requirements on the LCD screen. The MFD has the ability to deal with various types of video formats and communication protocols as well as viewing characters on screen display and video processing abilities. The MFD

has two configurations; landscape installation (Army, is shown in figure 10) and portrait installation (Navy, is shown in figure 11), both in the size of 8X6 inches. The operator can control the brightness of the LCD screen as well as switching from ON to Stand-By and vice versa by operating OSS on bezel.

The pixels within the liquid are arranged from upper left to lower right in a matrix of lines and columns. Each junction of the matrix includes a Thin Film Transistor (TFT) enabling dynamic and rapid illumination adjustment of the pixels.

The pixels and subpixels are fed by drivers from auxiliary ORG card in CDS (and not part of the LCD matrix like in MFD). The drivers operate like shift registers that receive and store serial data and controlled by a pixel clock.

Each pixel is composed of three colored sub pixels (red, green and blue; RGB). In order to display the picture, it is necessary to illuminate a white light behind the glass, whilst opening and closing the subpixels obtains a sharp and colored picture.

The luminescence transmission is low and requires a strong illumination source at the back (backlight). This illumination source is 20 times higher than the required luminescence level at the display's front.

**LCD Description**

The LCD is a high quality, fully sunlight readable display. The LCD module provides among other features, Anti Reflective (A/R) coating coated on the front display surface and environmentally ruggedness. The nominal display area of the LCD is 3 inches by 4 (5 inches diagonal) inches with image resolution of 234 x 320 RGB pixels and 64 levels per color. The pixels in the LCD arranged in a matrix of lines and columns. Each junction of the matrix enables illumination adjustment of the pixels.

**4. Software Implementation**

The steps given below have to be followed for loading the software onto DMM in the existing method:

- 1) Connect 28V DC power supply to the DMC J1 connector.
- 2) Connect the software loading kit to the DMC J5 connector.
- 3) Connect the Ethernet cable of DMM to the laptop Ethernet port and the RS232 cable of DMM to laptop RS232 port.
- 4) Open ProComm plus Terminal in the dedicated laptop.
- 5) Press PRESET button on the software loading kit.
- 6) Select software loading mode on the kit.
- 7) Select FLOADER in the terminal.
- 8) Choose the input device as Ethernet.
- 9) Enter the IP address of DMM.
- 10) Enter the netmask as 255.255.255.0.
- 11) Enter the TFTP server address as on TFTP server.
- 12) Enter the file name.
- 13) Enter the directory name.
- 14) Save the network configuration.
- 15) Configure the path in the TFTP server.
- 16) Quit and save

- 17) Load files to flash.
- 18) Save
- 19) Wait for the software to get loaded.
- 20) Check the checksum for the software loaded.

The steps has to be followed for loading the map in the existing method is given below:

- 1) Connect 28V DC power supply to the DMC J1 connector.
- 2) Connect the software loading kit to the DMC J5 connector.
- 3) Connect the Ethernet cable of DMM to the laptop Ethernet port and RS232 cable of DMM to laptop RS232 port.
- 4) Open ProComm Plus terminal in the dedicated laptop.
- 5) Select PRESET button on the software loading kit.
- 6) Select MSL LOADER in the terminal.
- 7) Format the existing data in the flash memory by giving the command "format ful".
- 8) Load the files path.dat and heli\_128.raw in the flash.
- 9) Create a new directory for the current map to get loaded by using the command "mkdir army/airforce/ navy"
- 10) Link the file that has the script for loading the particular map to the terminal.
- 11) Load the dtlist.txt file to the code.
- 12) Wait till the map gets loaded.
- 13) Once the map gets loaded the DMC is integrated with the test bench to check for the proper working.

#### Drawback of the existing method:

In the existing method a dedicated technician is required to sit along with the system to load the software and map. This is not accurate as there are so many command to run the files. There can always be mistakes while entering the commands the there might be confusion in the sequence of steps that has to be entered. So our project will reduce or merely remove all the errors caused due to human negligence and interaction.

For software to get loaded it takes around 7-8 hours. So by automating it can reduce the time to 1 hour. DMC is a highly faulty unit. Many number of LRU's keep coming for repair now and then. So it becomes hectic for the technician to repair the DMC's. As we have reduced the operating time in our project the technician can now check and repair many number of DMCs.

## 5. Conclusion

The test kit is capable of uploading software and it is portable which is directly used in helicopter. This test kit can be carried to Bases i.e., military base, naval base Etc. There is no need of removal and transportation of DMC from helicopter by which it reduces cost and men power. It also reduces damage occurring to the DMC during transportation.

The design of test kit has been completed based on analysis of various components. The respective diagrams are also shown for detailed study of the kit. Here, it has been concluded that the kit is very much necessary for testing the proper working of the DMC and MFD which reduces the risk and cost. Finally this design is fulfilling all the objectives, which are needed for the testing.

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