2023

INTERNSHIP TRAINING REPORT

Submitted By:

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B-Tech in Electronics & Communication Engineering.

To:

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PREFACE

I am thankful to HAL AVIONICS DIVISION KORWA management for providing the precious opportunity to witness one of the best avionics facilities. Also this gave the opportunity to learn about the fighter planes and their working.

During the vocational training, I was posted to the A&T-R department. The primary objective of my project is to get an overview of the electronic equipment & partial study of fighter aircrafts.

At all it was a memorable experience of working in such a large public sector unit.

During the period of training, I have learnt a lot about the electronic components used in the avionics division and the different parts of fighter jets manufactured and tested in the industry.

ALKESH SHUKLA
B-TECH 2nd YEAR

Electronics & Communication Engineering
Indian Institute of Information Technology
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Hindustan Aeronautics Limited
Avionics Division Korwa

CERTIFICATE

This is to certify that **"ALKESH SHUKLA" (B. Tech 2nd year) in Electronics & Communication Engineering Student of Indian Institute of Information Technology, Sricity Chittoor Andhra Pradesh** has successfully completed training in "**A&T-R department at HAL Avionics Division Korwa**" under my guidance from **1st June'2023 to 30 June'2023**. The produced report is genuine and has not been submitted elsewhere for any reason whatsoever. There is no confidential data in training report. I am fully satisfied and appreciate the work done on the project.

I wish good luck for the bright future of the candidate.

Om Prakash Yadav
Chief Manager (A&T-R)
HAL Avionics Division, Korwa

ACKNOWLEDGMENT

It gives me immense pleasure to state that I have been given opportunity to produce training report at **HAL Avionics Division Korwa** for a period of four weeks. I have a long list of people to acknowledge and because of their active efforts & suggestions, the project has been completed well within the time schedule & with the desired quality.

First of all I would like to acknowledge General Manager HAL Korwa for his kind approval of my training. I would like to thank **Mr. O. P. Yadav, CM (A&T-R), Mr. Mahesh Babu, CM (A&T-R)** for my deputation in the prestigious **Assembly & Testing-Russian** department. Also, I would like to thank Mr. Saurabh Kumar Maurya, SM (A&T-R) for devoting their prestigious time.

My Special thanks and gratefulness to Mr. Vinay Kumar Sharma (Senior Chief Supervisor), Mr. Vijay Kumar (Senior Master Technician), Mr. Ankit Rastogi (Senior Master Technician), Mr. Deepak (Senior Master Technician), with whom I actually worked and learned the basics of work in the industry as well as the practical knowledge.

ALKESH SHUKLA

CONTENTS

CONCEPT OF TRAINING

Every organization needs to have well trained and experienced people to perform the activities that have to be done. If the current or potential job occupant fail to meet this requirement, training becomes important as it raises the skill levels and increase the versatility and adaptability of the employees. Training thus becomes all important & a complex job.

In a rapidly changing society, employee, training is not only an activity that is desirable but also an activity that an organization must committing source to, if it is to maintain a viable and knowledgeable work force.

Training is a process of learning a sequence of behaviour; it is an application of knowledge. It gives people an awareness of the rules and procedure to guide their behaviour. It attempts to improve their performance on the current job or prepare them for an intended job.

IMPORTANCE OF TRAINING

Training is the corner stone of sound management for it makes the employees more effective, efficient and productive. It is actively and intimately connected with all the personnel and managerial activities functionally inter related.

Training is a practical and vital necessity because apart from the other advantage mentioned earlier, it enables employees to develop and rise within the organization and increase their market value, earning power and job security. It enables management to resolve sources of friction and make them aware of the fact that the management is not divisible. It also helps them to achieve better co-operation with the company and a greater loyalty to it.

Training, on one hand, benefits the management by high standards of quality and on the other hand heightens the morale of the employees because it helps in reducing dissatisfaction, complaints, grievances absenteeism and also reduces the rate of turnover.

HAL: An Overview


Seth Walchand Hirachand

Hindustan Aeronautics Limited (HAL) came into existence on 1st October 1964. The Company was formed by the merger of Hindustan Aircraft Limited with Aeronautics India Limited and Aircraft Manufacturing Depot, Kanpur.

The Company traces its roots to the pioneering efforts of an industrialist with extraordinary vision, the late Seth Walchand Hirachand, who set up Hindustan Aircraft Limited at Bangalore in association with the erstwhile princely State of Mysore in December 1940. The Government of India became a shareholder in March 1941 and took over the Management in 1942.

At present, HAL has 19 Production Units and 10 Research and Design Centres in 10 locations in India. The Company has an impressive product track record- 15 types of aircrafts/Helicopters manufactured with in-house R & D and 14 types produced under license.

HAL has been successful in numerous R & D programs developed for both Defence and Civil Aviation sectors. HAL has made substantial progress in its current projects:

- Dhruv, which is Advanced Light Helicopter (ALH)
- Tejas - Light Combat Aircraft (LCA)
- Intermediate Jet Trainer (IJT)
- Various military and civil upgrades.

Dhruv was delivered to the Indian Army, Navy, Air Force and the Coast Guard in March 2002, in the very first year of its production, a unique achievement.HAL has played a significant role for India's space programs by participating in the manufacture of structures for Satellite Launch Vehicles like:

- PSLV (Polar Satellite Launch Vehicle)
- GSLV (Geo-synchronous Satellite Launch Vehicle)
- IRS (Indian Remote Satellite)
- INSAT (Indian National Satellite)
- HAL has formed the following Joint Ventures (JVs) :
- BAeHAL Software Limited
- Indo-Russian Aviation Limited (IRAL)
- Snecma-HAL Aerospace Pvt. Ltd
- SAMTEL-HAL Display System Limited
- HALBIT Avionics Pvt. Ltd
- HAL-Edgewood Technologies Pvt. Ltd
- INFOTECH-HAL Ltd
- TATA-HAL Technologies Ltd
- HATSOFF Helicopter Training Pvt. Ltd
- International Aerospace Manufacturing Pvt. Ltd
- Multi Role Transport aircraft Ltd

Apart from these seven, other major diversification projects are Industrial Marine Gas Turbine and Airport Services. Several Co-production and Joint Ventures with international participation are under consideration. HAL's supplies / services are mainly to Indian Defence Services, Coast Guards and Border Security Forces. Transport Aircraft and Helicopters have also been supplied to Airlines as well as State Governments of India. The Company has also achieved a foothold in export in more than 30 countries, having demonstrated its quality and price competitiveness.

HAL has won several International & National Awards for achievements in R&D, Technology, Managerial Performance, Exports, Energy Conservation, Quality and Fulfilment of Social Responsibilities. HAL was awarded the “INTERNATIONAL GOLD MEDAL AWARD” for Corporate Achievement in Quality and Efficiency at the International Summit (Global Rating Leaders 2003), London, UK by M/s Global Rating, UK in conjunction with the International Information and Marketing Centre (IIMC).HAL was presented the International - “ARCH OF EUROPE” Award in Gold Category in recognition for its commitment to Quality, Leadership, Technology and Innovation. At the National level, HAL won the "GOLD TROPHY" for excellence in Public Sector Management, instituted by the Standing Conference of Public Enterprises (SCOPE) & Raksha Mantri's Awards for Excellence for the years 2006-07, 2007-08 and 2008-09.HAL was awarded the MoU Excellence Award for the years 2004-05, 2005-06, 2006-07, 2007-08 and 2008-09. HAL was even awarded the "Supplier of the Year 2009" by Boeing, USA. The Company scaled new heights in the financial year 2009-10 with a turnover of .11457 Crores.

- *Diversification:*

Since its inception, HAL has come a long way to become Asia’s premier Aircraft manufacturing company. It is also one of the very few vertically integrated aircraft manufacturing company in the world. Today HAL with its corporate headquarters at Bangalore has got 15 production divisions & 9 R & D centers spread over 10 different locations all over India. It has a pool of around 50,000 highly skilled managers, engineers and technicians.

Over the past five decades HAL has spread its wings to cover various activities in the areas of design, development, manufacture and maintenance of light aircraft, piston and jet trainers, advanced fighters, combat aircraft systems, equipment and avionics. The manufacturing divisions are fully backed by design centers for R & d support. New initiatives in R & D such as Advanced Light Combat Aircraft (LCA), MIG, Jaguar and Sukhoi-30 and their update programmes as well as co-production for civil aviation.

- Dealings:

HAL was found basically to cater the requirements of Indian Air Force (IAF) in aeronautic field as well as in civil aviation. However, IAF is the main customer of HAL. Also it satisfies the needs of Army and Navy and various other organizations like Defence Research Development organization (DRDO) & Vikram Sarabhai Space Center (VSSC) etc.

- *Exports:*

HAL exports various civil & fighter aircraft parts to France, UK & USA. Efforts are on to export the ALH (ADVANCE LIGHT HELICOPTER).

Besides manufacturing hi-tech aircrafts like Jaguar, MIG-27 & Sukhoi-30 etc:

- HAL has successfully designed and flown Advanced Light Helicopters (ALH)
- It is engaged in development of Light Combat Aircraft (LCA)
- It is modestly entering into the international Market.
- It is also diversifying its portfolios into the non-defense particularly communication, software and consultancy.
- Recently, Government of India has launched Integrated Guided Missile Development Programme (IGMDP), which also requires good contribution from HAL.
- Many of the systems used in missile systems like Accelerometers etc are also being manufactured here.

➢ *HAL-About The Company:*

Hindustan Aeronautics Limited is an organization where integrated air borne weapon platform are developed, manufactured and serviced. It is one of the few corporate giants in Asia whose capabilities span the entire range of activity from product conception to after sales support. H.A.L. is also involved in the manufacture and assembly of system for India's space program.HAL has manufactured following aircraft & helicopters.

- MARUT MK-1
- CHETAK
- KIRAN MK-1
- CHEETAH
- MIG-21M
- BASANT
- AJEET
- JAGUAR
- MIG27M
- HTT34
- DORNIER
- PUSHPAK

In addition to the indigenization efforts of the division for HAL made products, more than 3800 items pertaining to the following non-HAL made aircraft also have been indigenized.

- MI-8, MI-17, MI-25, MI-26, MI-35
- IL-38, IL-76
- MiG 23, MiG-29

HAL has 18-production division and 10 Research and Development centres. Core businesses of HAL are:

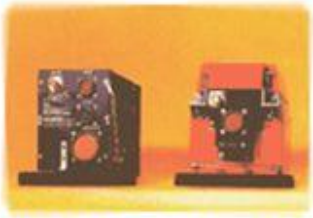
- Design and development of Fixed and Rotary Wing Aircraft, Avionics and Accessories.
- Manufacture, Maintenance, Repair and Overhaul of:
    - Fighter, Transport and Trainer Aircraft.
    - Helicopter.
    - Aero Engine.
    - Avionics.
    - Accessories.

- Ground Support Equipments.

- Manufacture of structural components for Satellite and Launch Vehicles.
- Software develops for Aerospace application.
- Design consultancy.

➢ *H.A.L. Products*

Communication / Navigation Equipment



Advanced Communication Equipment

Accessories for Aircrafts, Helicopters & Aero Engines

Aerospace Equipment

Aero Engines of Russian Origin

Aero Engines of Western Origin

Aircrafts of Russian Origin

Aircrafts of Western Origin

Helicopters

➢ *Divisions & Units*

HAL-CORPORATE

BANGALORE COMPLEX

- Aircraft Div.
- Aerospace Div
- Engine Division
- Helicopter Div.
- F & F Div
- OVERHAUL DIV.
- Industrial & Maine Gas
- Turbine Div.

MIG COMPLEX

Nasik Div.

Koraput Div.

ACCESSOREIS COMPLEX

Hyderabad Div.

Kanpur Div.

Lucknow Div.

Korwa Div.

HAL-AVIONICS DIV. KORWA & ITS PRODUCTS

HAL-AVIONICS DIV.KORWA was established in1980.The division manufactures, repairs and maintenances advance Avionics systems of JAGUAR, MIG-27, SU-30 and UAV military Aircrafts of IAF.

The facilities include well equipped electronic assembly shops of international standard having sophisticated instruments and machines. The machine shop is also equipped modern NC Machines. The division has also got suitable facilities for design and development of advance avionics for military aircrafts. The division has got approval of ISO 9001:2000 for its quality system and ISO14000:2000 FOR ITS ENVIRONMENTAL CONTROL practices.

DEPARTMENTS

For proper functioning of the Division, it is divided into various departments, according to the type of work. These departments are:

- Assembly and Testing-Russian
- Manufacturing
- Assembly and Testing-Jaguar
- STEG
- Management Services Department
- Design
- Vigilance
- Integrated Material Management
- Civil
- Process Shop
- Finance / Account
- Training Department
- Plant Maintenance
- Method
- Customer Services
- Marketing
- Quality Control
- Planning and Production control
- Human Resource
- Forward Planning
- Computer Section
- Security
- Medical

Product Range of Jaguar.

- **Flight Data Recorder**
  - Recording Duration Of 90 Min
  - Recording Of Data & Audio Track
  - Crash Protected Data Recording
- **Inertial Navigation System**
  - Digital Nav-Attack System
  - Stabilized Inertial Platform
- **Combined Mapped and Electronic Display**
  - Head Down Navigation & Map
  - Soft Key Selectable Display Mode
- **Laser Ranger and Marked Target Seeker**
  - Range To Target Computation
  - Operates In Ranging & Seeking Mode
- **Head Up Display & Weapon Aiming Computer**
  - Head Up Display & Sighting System
  - Weapon Aiming Computation
- **Autostabilizer System**
  - Computer Based System For Control Of Tail, Rudder & Spoiler

Product Range of Sukhoi (SU- 30 MKI).

OPTOELECTRONI SIGHTING & NAVIGATION COMPLEX 'OEPrNK'

- *Opto-Location Station*
- *Directional & Vertical Strap Down System*
- *Coupling & Data* Conversion Block
- *Inertial Measuring* Block
- Re-Programmable Memory Block
- System Panel
- Air Data Computer
- Art. Sura
- Complex Power Supply Unit

- *Multi Function Displays 55s*
- *Multi Function Displays 66s*
- *Collimator Aviation Indicator With UFCP*
- *Digital Map Generator*
- *Inertial Navigation & Global Positioning System*
- *Airborne Digital Computer*
- *Weapon Control System*
- *Computer Based Stand by Indicators Gyro Horizon Vertical Speed Indicator Altitude Indicator Mach-Speed Indicator*

Project Report:-

OLS Shop (Optical Detection & Laser Station) SU30MKI Laser-optical locator systemOLS-30 laser-optical locator system to include a day and night FLIR capability and is used in conjunction with the helmet mounted sighting system. The OLS-30 is a combined IRST/LR device using a cooled, broader waveband, sensor. Detection range is up to 90 km; whilst the laser ranger is effective to 3.5 km. Targets are displayed on the same LCD display as the radar.OLS since has works and uses two main systems **Infrared(IR) & Laser Ranger(LR).** It works in the following three main stages:

OLS optical detection pod used on Su aircraft.

a) Tracking mode or Hunting mode: In which it continuously searches its surroundings upto a range 90Km in hte frames of 60° X 10° frames. If anyother plane gets detected then it moves to next stage.

b) Small Field Coordinate Supply: In this mode it zeros down on the target by narrowing its field of view. It does so until the target approaches 5km range of the plane. It does it in 2 stages. Initially it reduces its frame to 3°X 3 °. Next it further reduces its frame size to further increase its accuracy and track the target by using a frame of 40'X40'.

c) Lock On: This mode activates only when the aircraft reaches within the range of 3km from the plane. It is at this stage that the laser system gets on begins to continuously lock and track the opponent plane, so that it can be engaged.

Whole of this unit works at power supply of 27V DC and 115V 3-phase AC. The unit is mounted inside a very hard and rigid body with the separate IR and laser systems inside it. Since, an IR sensor works on the principle of detection of the IR waves emitted by the Hot gases (about 1800-1200°C) coming out from the nozzle of the jet engine of the enemy plane, it relies heavily on the temperature differences created in its field of view. So, it needs to be protected from the temperature variations arising within itself also. This is the main reason that unit's IR part works at the temperatures of -60°C i.e. 203K , also called as 'Subcryogenic' systems as they are capable of attaining such low temperatures so quickly. The IR and laser part of the received signals are separated from each other so that the IR equipments are not burned down by the laser's energy. It is done by using a partially reflecting mirror with 156 different coatings to separate laser and IR radiations from each other. The IR radiations are detected through an array of 64 photodiodes where an IR image similar to the one received on the receiver is formed.

The main function of this unit is to provide the weapon system and mission computer with the x,y coordinates of the opponent plane and its distance relative to it. The main sensor is placed on the right of the second planet on the airframe of the plane.

LITENING targeting pod (Israeli): LITENING targeting pod is used to target the laser guided munitions. Litening incorporates in a single pod all the targeting features required by a modern strike fighter. The original Litening pod includes a long range FLIR, a TV camera, a flash-lamp powered laser designator, laser spot tracker for tracking target designated by

other aircraft or from the ground, and an electro-optical point and inertial tracker, which enabled continuous engagement of the target even when the target is partly obscured by clouds or countermeasures. The pod integrates the necessary laser rangefinder and designator, required for the delivery of Laser Guided Bombs, cluster and general purpose bomb.

INPUT DATA /OUTPUT DATA

INPUT DATA:

(i) System ensures reception of IR (infra-red) signals from airborne as well as ground & water surface target.
(ii) System ensures reception and conversion of up to 64 analogue signals to digital in Optical & Mechanical Unit (OMU).
(iii) Reception of angular co-ordinates and present range of target tracked by channel no. 11 of 64 channels, while acting as slave channel
(iv) System ensures reception LASER beam reflected from targets by LASER Range Finder (LRF).

OUTPUT DATA:

(i) Detection, lock on and tracking of aerial targets against clear sky, Cloud, ground surface and water.

(ii) Measurement of range of air targets by use of Laser Range Finder (LRF).

(iii) Information display regarding combat against air and ground target for employment of gun.

PRINCIPLE OF OPERATION:

Basic principle of operation:

*Any object, whether solid, liquid or gas whose temperature is above absolute zero (-273 degree c or 0 degree k) would emit electromagnetic radiation. if the object is in thermal equilibrium with its surroundings it simultaneously radiates and absorbs energy at the same rate in the form of a continuous spectrum of infrared radiation. This radiation phenomenon may be described by an emitting efficiency factor known as emissivity. The value of emissivity of real body is given with the ratio of radiant emittance of real body to that of a black body at the same temperature Example: Aluminum has an emissivity value 0.55

Human skin has a maximum value of emissivity of 0.98.

It is evident that good reflectors are poor emitters of radiation since they have low emissivity where as, poor reflectors are good emitters of radiation since they have high emissivity.

*Transmission of IR radiation in atmosphere is effected in the same way as that of visible light, i.e. by absorption and scattering by molecules and by presence of aerosols and

particles. The diameter of aerosol particles plays a great role. Of these processes, absorption proves to be the more dominant at IR wavelength, whereas scattering is more dominant for visible light. The diameter of different type and aerosols Particle is shown in fig.

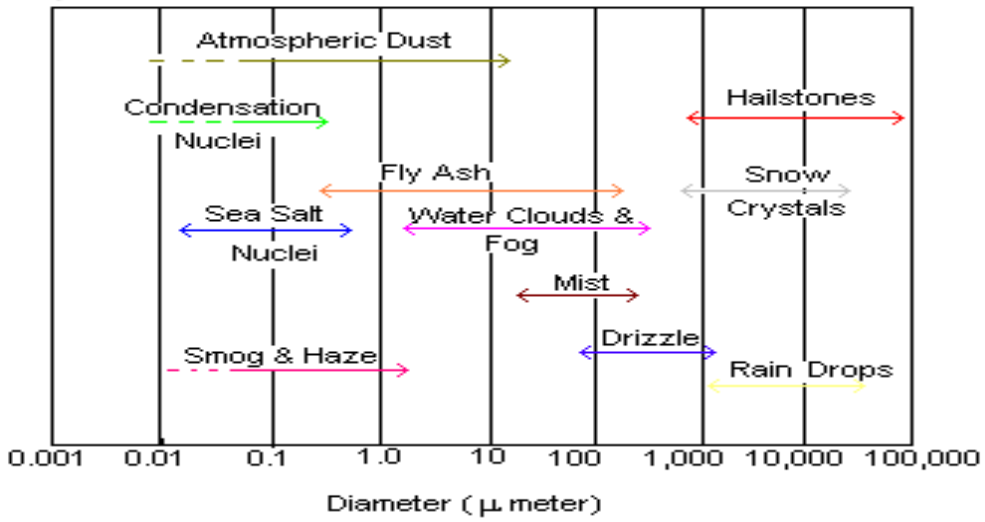


Fig. The diameter of different type aerosol particles of atmosphere

In the atmosphere the infrared radiation (IR Signal) passes through different several regions. Some Atmospheric regions can pass the infrared radiation (IR Signal) without absorbing the IR Signal and some region can absorb the IR signal. Atmospheric regions they have high transmittance is known as “atmospheric windows” .This regions are separated by regions of high absorption. The principle windows that can be used for thermal imaging are 3 to 5 μm and 8 to 14 μm.

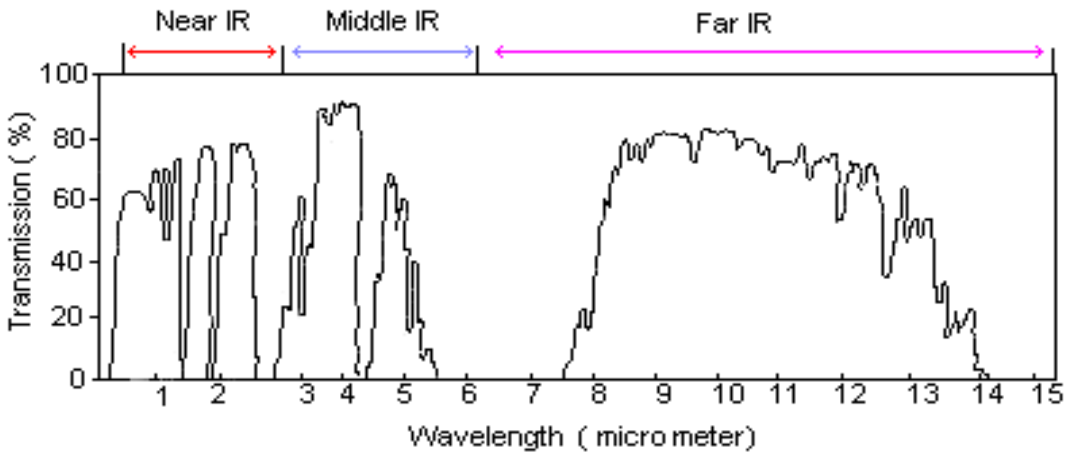


Fig. Atmospheric Windows (near sea level in horizontal path)

- **Distortion and absorption of IR Signal can be enumerated in the following points:-**

(i) Transmission in 8 to 14 μm window is dominated by molecular absorption

Whereas transmission in the 3 to 5 μm window is influenced more by aerosol Scattering.

(ii) Transmission in 8 to 14 μm, for a distance less than 10 Km, appears to be better in most of the occasions whereas transmission in 3 to 5 μm window, for a distance more than 10 Km, is superior in high humid and extreme clear conditions.

NOTE: The optical detecting and tracking system of modern aircraft is designed to detect

the infra-red wave band of 3.5 – 5.5 μm.

- ***Working principle:***

The working of OLS is detection of target & measuring the distance of target

hence its working principles are divided into following two parts:

a) Detection Principle

b) Range Measuring Principle.

Detection principle :

Thermal detector of OLS-30 detects the target based upon its Infra- Red radiation. IR emission by a target in rear hemisphere is more than that in front hemisphere. Energy of heat emission is expressed by Boltzmann Law as:-

$$R = {}^{\delta}T^{4}$$

Where, δ = Boltzmann Constant (1.38×10^{-23} m^2 Kg s^{-2} K^{-1})
T = Absolute temperature of a body.

This heat gives rise to radiation of IR waves. Wien's Displacement law gives the relation between IR wavelength and absolute temperature expressed as:-

$$\lambda_m = 2897 / T$$

Where λ_m = Maximum wavelength of IR radiation

T = Absolute Temperature of the body.

These infrared waves are detected with the help of photocells having a detection bandwidth of 3.5 to 5.5 μm of wavelength to cover the entire range of radiation by the target either in front or rear hemisphere.

Range measuring principle :

LASER is used in the form of a pulsed signal for finding out the range of the

Target Time taken by a LASER beam to travel to and fro is computed to

measure the range as per following relationship:-

$$d = \frac{C*t}{2}$$

Where, d = range of the target

T = time taken to travel to and

C = velocity of light

- **TECHNICAL CHARACTERISTICS:**
  - **Thermal detector:-**

(a) Detection range:-

(i) At MAX rating of engine in forward hemisphere:

D_{acq} : 90-100 Km (in clear sky with aspect angle 0/4-2/4).

: 50-60 Km (against clouds, surface of ground and water with aspect angle 0/4-2/4).

(ii) At REHEAT rating in rear hemisphere:

D_{acq} : 50 Km (with ¼ aspect angle)

(b) Lock on range:-

(i) In general D_{lock} on : 70% of D_{acq}

(ii) In FHS D_{lock} on : 10 Km (with target at max rating within aspect angle 5° to 15°)

NOTE :	In FHS, aspect angle should be=15° to have a longer D_{lock} on of target flying at high altitude with high airspeed

(c) Optical axis : -7.5° w.r.t. Aircraft longitudinal axis

(d) Scanning zone : 60°×10° (Big field mode)

: 20°×5° (Small field mode)

: 3°×3° (Lock on mode)

(e) Scanning mirror search zone : ±60° in Azimuth

: -15° to +60° in Elevation

(f) Band of thermal detection : 3.5 to 5.5 μm of wavelength

(g) Fairing optical glass : Glass TCM 209 (Transparence 0.5 to 5.5 μm)

(h) Cooling material used : Liquid Nitrogen

(j) Cooling temperature : 77°K

(k) Photo detector material : Indium Stabium

2. LASER Range Finder:-

(a) Max range	:	3 Km (for air target) & 5 Km (for ground target)
(b) Min range	:	300 meter
(c) Wave length	:	1.06 μm
(d) Pulse width	:	40 to 60 n sec
(e) Pulse radiation energy	:	0.4 to 0.5 joule
(f) Pulse radiation power	:	10^7 watt
(g) PRF	:	0.25 Hz (Duty mode)
(i) PRF	:	2 Hz (Main mode)
(h) Active material	:	Neodymium doped glass
(j) Cooling material	:	S Kha Z 8
(k) Cooling temperature	:	35°c
(l) Max transmission time	:	15 Min. (3.5 Min in main mode & 11.5 Min in duty mode)

- **COMPOSITION & FUNCTIONAL DETAILS :**

Optical detection and tracking system consists of:

(A) Mono block
(B) Power Supply Unit
(C) Correction Unit

The block diagram optical detection and tracking system is shown in fig. and photograph is shown in fig.

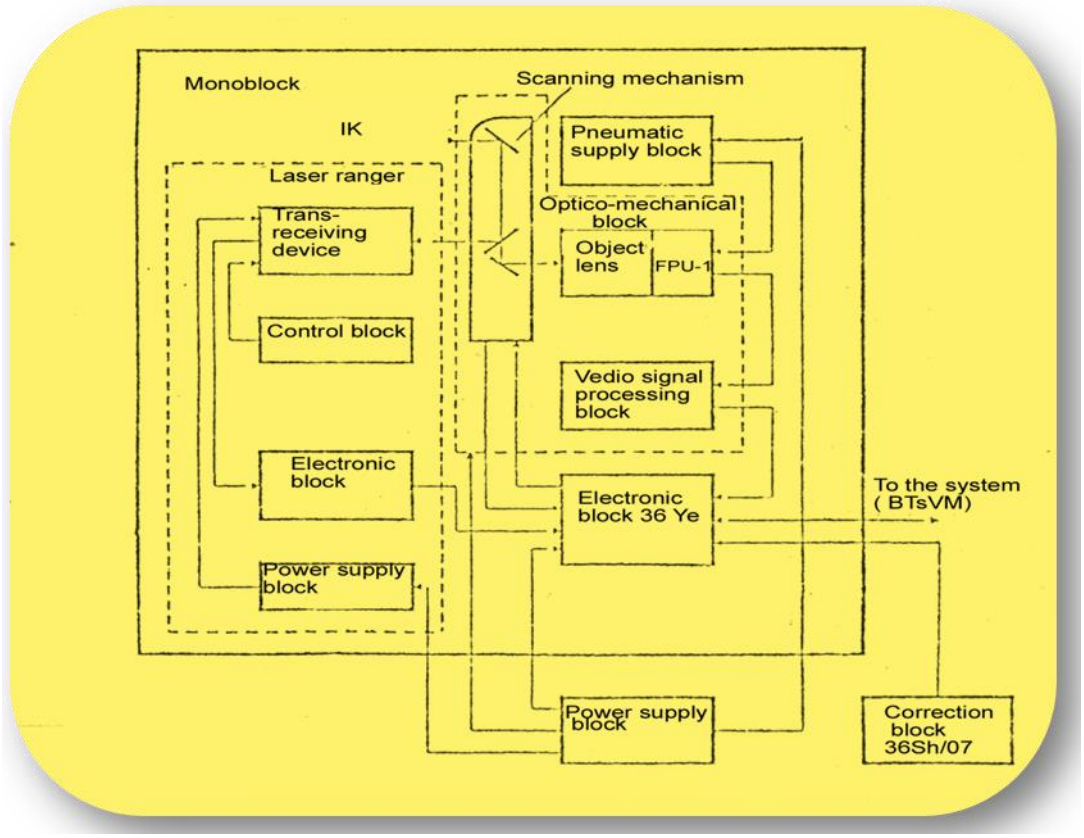
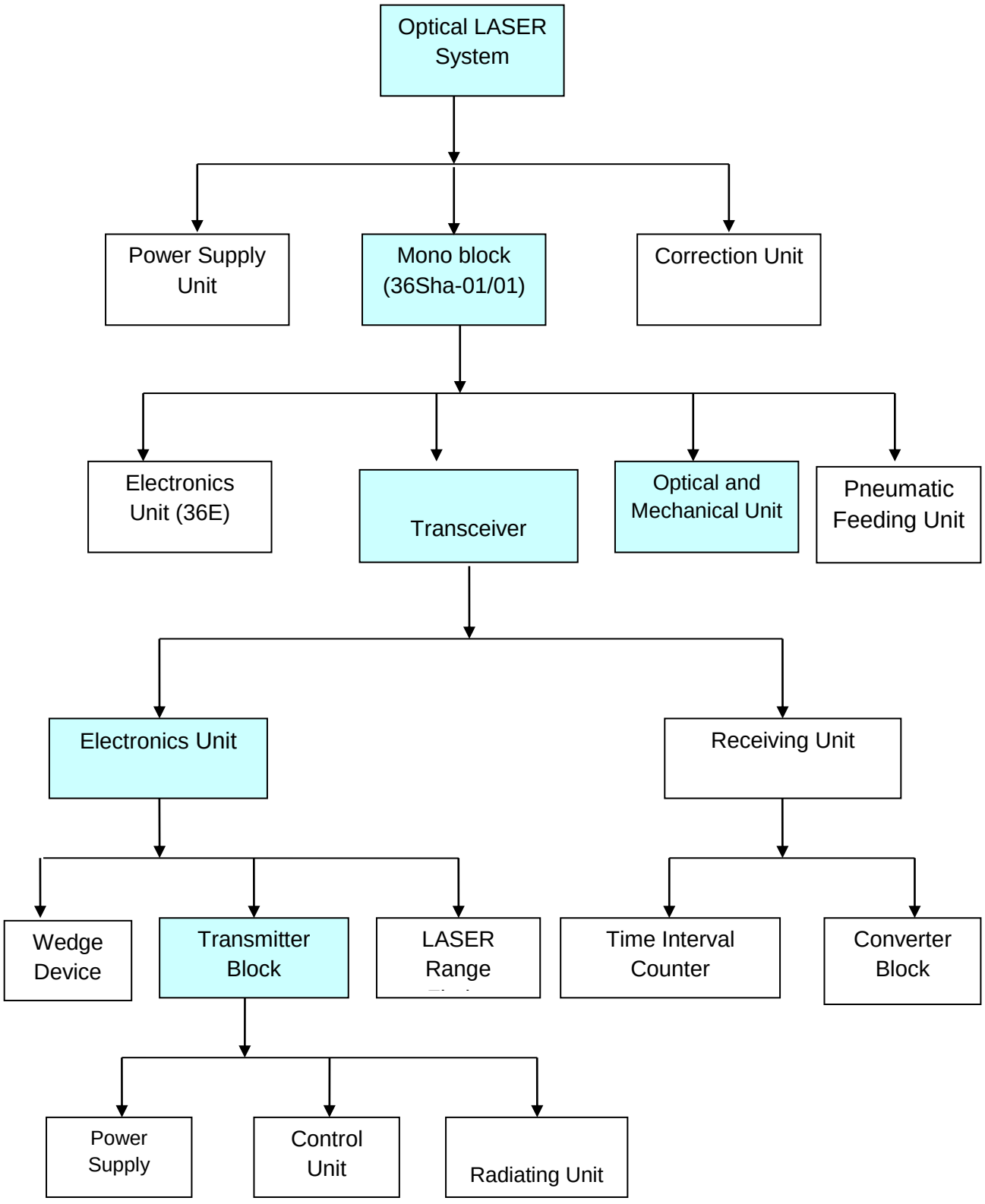
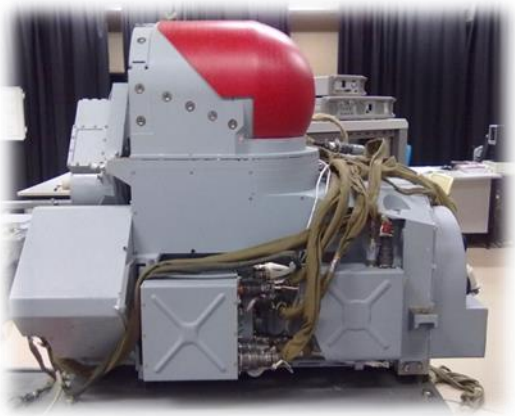


Fig. Block diagram optical detection and tracking system

- ***Family tree of OLS :***





MONOBLOCK

CORRECTION UNIT

POWER SUPPLY UNIT

(A) Mono block:

The Mono block c

(**1**) Optical and Mechanical Unit (OMU):

(**2**) Electronics Unit (36E)

(**3**) Pneumatic Feeding Unit

(**4**) LASER Range Finder:

(1) Optical and Mechanical Unit (OMU):

Opto - mechanical block (BOM) is meant for:

(i) Viewing given field of scanning; Receiving infrared radiation, frequency processing of signals and their amplification in 64 channels.

(ii) Supplying coordinate of line of sighting on azimuth and angle of elevation;

Supplying position coordinate of FPU-1 with modulator on bank;

(iii) Tracking target by commands from electronic block 36Ye; Controlling diaphragm; Simulation input stream in the form of point (<<dot>>) and dimension (<<ruler>>) targets along 64 channels in built-in test mode; Generating signals <<zero – of sensors>>;Controlling modulator;

Opto-mechanical block (BOM) is consist of:

(I) Scanning Mechanism

(II) Objective Lens Unit

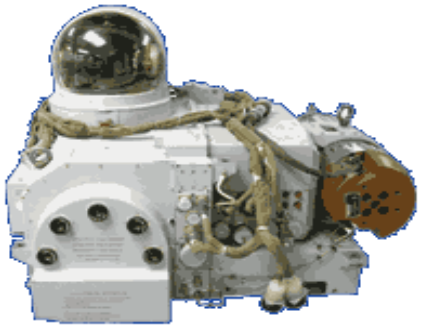
(III) Photo Detector

(IV) Video Signal Processing Unit

(V) Block <<zero-of sensor>>

Back view

Side view



Front view

Fig. Of Mono block

1. LRF,

2. Scanning mechanism,

3. Electronics unit (36 e),

4. Pneumatic feeding unit.

Scanning Mechanism:

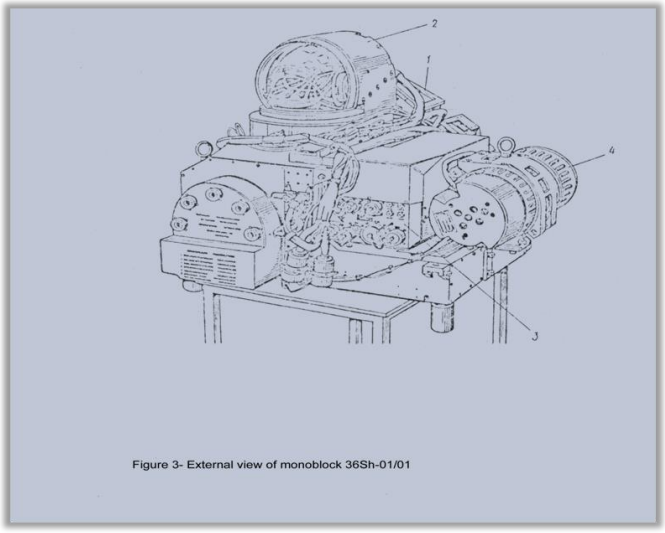


Figure 3- External view of monoblock 36Sh-01/01

It consists of scanning mirror, fixed mirror, filter, drive motor, azimuth and elevation converter, fairing glass. It is designed for viewing preset field of surveillance (±60° in A_z & -15° to +60° in El), letting direction of the optical axis run on the target in the tracking mode. Generating signal that determines position of the optical axis in the A_z & El coordinates.

LASER and IR are separated by filter and directed to their respective channels. Built in test Collimators designed for transmission of IR radiation from incandescent lamps to photo detector. Scanning mirror swing in El and Az with the help of two separate electric motor (DM-10) and respective converter (position transmitter 33E) is on the axis.

I) Objective Lens Unit & PD-1:

It's consists of mirror, lenses, modulator converter (zero transmitter) and photo detector. IR passes through 3 lenses element and reflected from modulator mirror to photo detector. IR radiation converted into electrical signal. 64 photo receiver arranged in a single vertical strip, covering 3°x3° area. Modulator mirror oscillate in 25Hz by angle ±1°30' during 3°x3° and 100 Hz by angle ±20' during 40'x40' tracking field.

II) **Video Signal Processing Unit:**

It is designed for processing and amplification of signal delivered from photo detector, summation of signal from 64 channels. It's got five amplifier units that amplify and carry out optimal signal processing through 64 channels and forms a target signal.

III) Block <<zero-of sensor>>

Block <<zero-of sensor>> is an optico-electronic system for generating signal, synchronized with oscillation mirror of the modulator.

2). Electronics Unit (36E):

It is a specialized digital-analog device deal with a great amount of input and output data. It's designed for:-

(a) To exchange data between Mission Computer (MC) and Optical & LASER System (OLS-30).

(b) To generate signal for scanning mechanism according to data received from MC and Optical & Mechanical Unit (OMU).

(c) To processes data on the basis of preset algorithm.

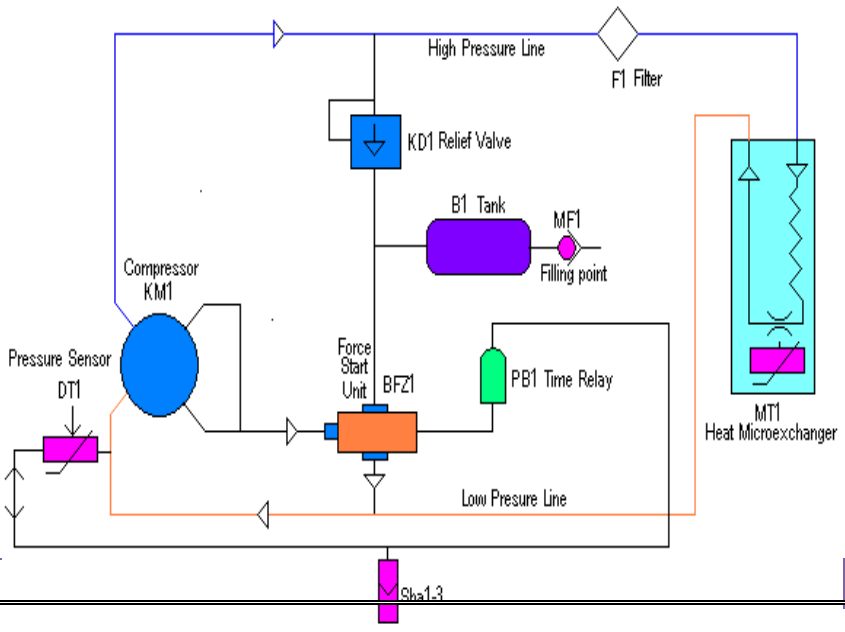
(d) To control operating mode of LASER Range Finder (12P2-03) and TD.

(f) To control operation of modulator.

(g) To make internal correction.

3). Pneumatic Feeding Unit:

Pneumatic Feeding Unit is meant for deep freezing of sensitive elements of photo receiving device ((PD-1) of thermal channel of OLS-30 and maintains temperature at 77°K. It is a single stage choke device, working in a closed cycle of gaseous mixtures. Liquid Nitrogen used as coolant. Fig. 12 shows the schematic diagram of Pneumatic Feeding Unit. Pneumatic Feeding Unit is operates in two mode i.e. Force mode and Steady mode. Initially it operates in Force mode. After the time set by time relay (PB1) its switch over to Steady mode.



(a) **Force mode operation:**

Once system is switch on, time relay get supply and energize electromagnetic valve of force start unit (BFZ1). Valve opens to connect T1 tank with low-pressure line. Resulting in increased amount of coolant flow through the low-pressure line. Compressor suction pressure increase from 0.2±1 Kgf/cm^2 (normal working pressure) to 1 Kgf/cm^2 and discharge pressure in high-pressure line is improved. Photo detector cooled down to the operating temperature quickly. Coolant is cooled in heat micro exchanger and come back to compressor through low-pressure line. Discharge pressure in high-pressure line is limited by Relief valve (KD1) at 160 Kgf/cm^2 and coolant discharge to tank.

(b) Steady mode operation:

On expiration of time set by the time relay (TR1), electromagnetic valve de-energize. T1 tank disconnect from low pressure line and connect to compressor. The coolant release from compressor to tank through BFZ1, until suction pressure reduces to set level 0.2±0.1 Kgf/cm^2. BFT1 automatically maintains pressure in the low-pressure line, in case pressure decline, coolant delivered from tank to low-pressure line.

(c) Pressure sensor (DT1):

It senses the pressure in low-pressure line. Coolant refill through fill coupler (MF1). Compressor motor power supply is 115 V 400 Hz 3 Phase. Pressure sensor powered by 6V DC. Time relay and electromagnetic valve operate in 27 V DC

4). LASER Range Finder (LRF) Operation:

Radiating unit generates LASER pulse according to mode of operation of LRF and it is decided by a command received from Mission Computer through electronics unit (12P2/01). Electronics unit in turn gives command to control unit (25F/02). Control unit generates a transmitter trigger pulse (TTP) depending on the duty or main mode and sync pulse for TIC (Time interval unit) Radiation takes place at a frequency of 0.25 Hz for Duty mode and 2Hz for Main mode, LASER pulse is transmitted to outer space through objective lens unit, fixed mirror, scanning mirror. The reflected LASER ray from the target gets filtered in scanning mechanism and directed by objective lens unit to photo detector of receiving unit. LASER ray is converted to electrical pulse by photo detector. Pulse shaper carries out primary processing of this electrical pulse and fed to TIC. When radiation starts, ref pulse generator generates a reference pulse that is delivered to TIC through pulse shaper to actuate the pulse counter in TIC. Once the echo pulse is received, time interval between transmitted and received signal is measured and corresponding range data is generated which is then sent to mission computer through electronics unit (36E). , Mission Computer gives various commands namely:-

(a) Switching on/off of the LRF

(b) Gate pulse to clear any range information

(c) Mode of operation (duty or main mode)

The laser range finder consist of

(i) Tran receiver:
(ii) Electronics unit.

B). <u>Power Supply Unit (36Sha/04)</u>:

It is designed for producing various stabilize and non-stabilize power supply require by Mono block (36 Sha-01/01). Input supply 115V 400 Hz 3 Phase. It has two parts

(a) P/S Unit -1

(b) P/S Unit -2

Outputs of power supply are as follows:

Stabilized Supply			
1.	5.25 V (2.3A)	**7.**	± 12.6 V (0.6A)
2.	5.25 V (1.7A)	**8.**	± 15 V (0.15A)
3.	5.25 V (1.2A)	**9.**	± 22 V (0.84 A)
4.	6.3 V (0.65A)	**10.**	10 V (0.4A)
5.	6.3 V (0.6A)	**11.**	20 V (0.4A)
6.	10 V (0.1A) Ref		
Non-Stabilized			
1.	40 V	**3.**	24 V (1.8A)
2.	45 V (2A)	**4.**	24 V (1.8A)

C). <u>Correction Unit:</u>

Correction Unit ensures adjustments of Optical LASER System on aircraft. The correction block is a constituent of OLS-30, meant for ensuring electric tuning of OLS-30, and meant for ensuring electric tuning of OLS-30 in the aircraft. Correction Unit is shown in Fig. -13 given below. It consists of 14 toggle switches. Toggle switches 1…7 are meant for carrying out settings (corrections) while the adjusting of OLS-30 in azimuth, toggle switches 8…14 are meant for carrying out setting while adjusting OLS-30 in angle of elevation. Value of lower order digit (toggle switches 7, 14) is equal to 1' 19''. The toggle switches 1, 8 are meant for fixing sign of setting.

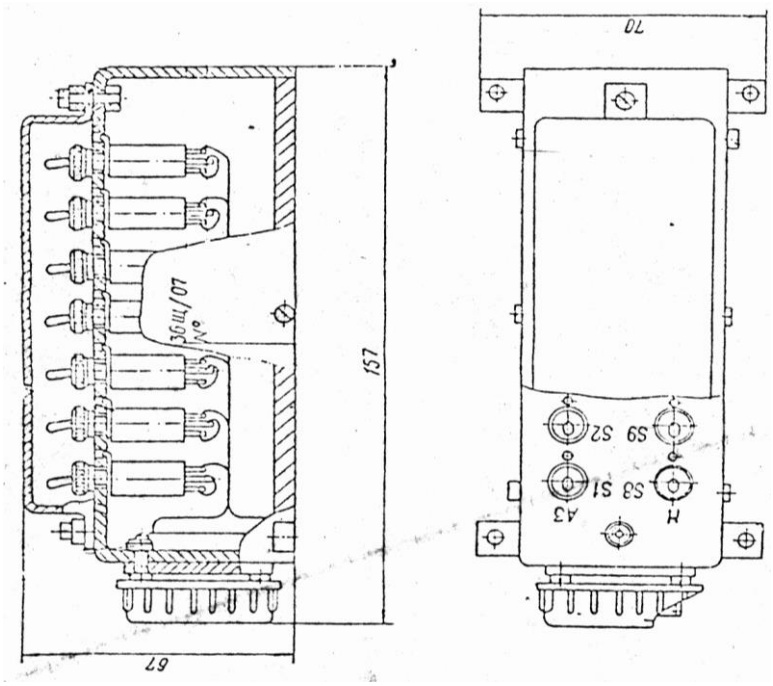
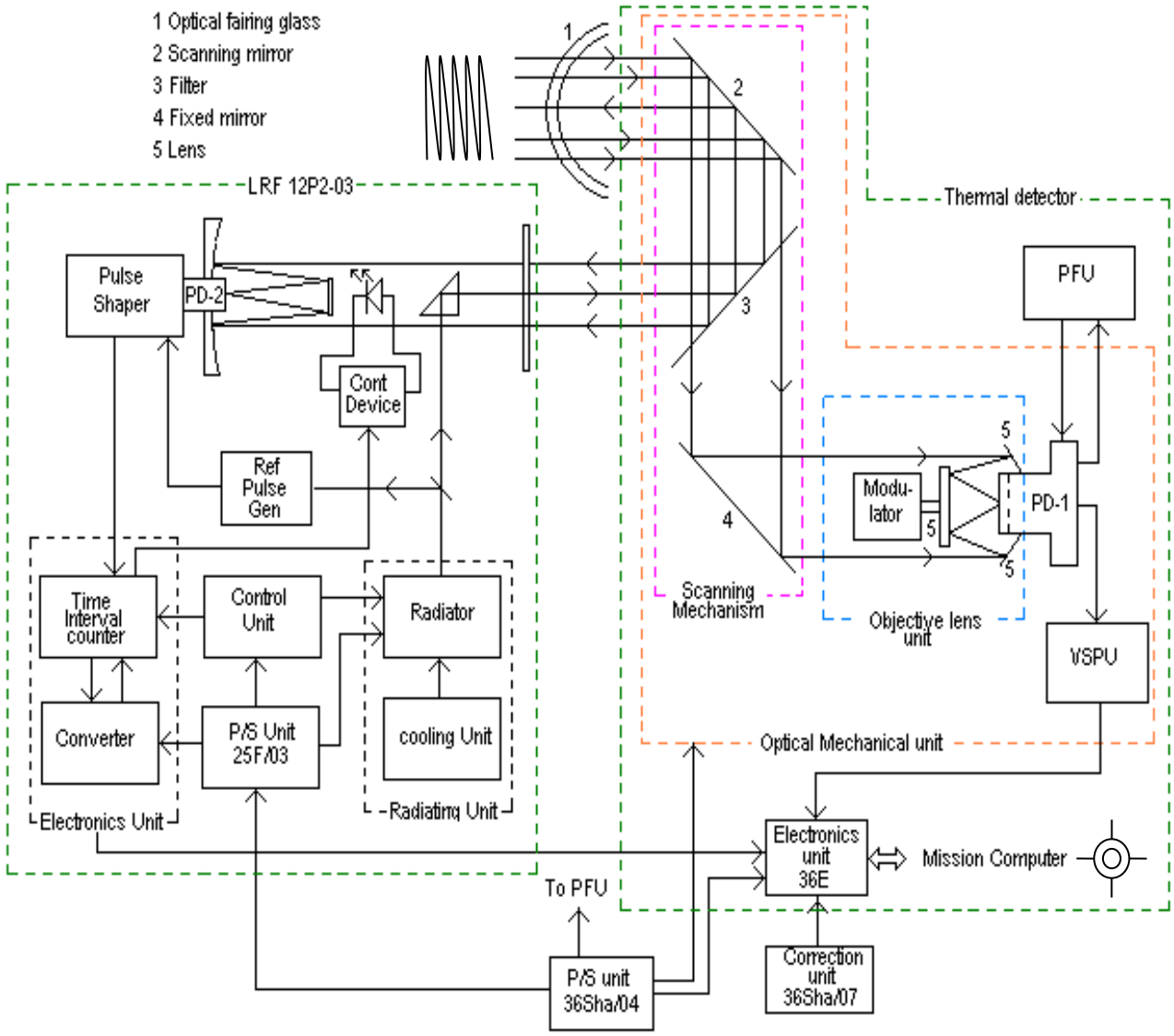


Fig. 13: <u>Correction Unit</u>

The Schematic Functions Diagram of OLS

The schematic functional diagram of Optical LASER System is given in following fig. 7



- ***Mode of Operation:***
- **Optical detection and tracking system has following operating modes**:

It has generally two modes. One infrared mode (IR mode), second laser mode (LR mode)

1) Mode of Operation of IR: In IR mode following article has four operational modes which are listed below.

a) Built-in control mode VSK “control”
b) Large field surveillance mode
c) Small field surveillance mode
d)Lock on & tracking mode

(a) BUILT IN TEST:

On receive of command “Test 12P-03” the Converter Unit generates command “Test-1” for TIC (Time interval counter). TIC generates two commands “Reference Test” and “Echoing” at a delay of 20 μs. Command “reference test” passes through the Pulse Shaper unit to TIC and actuates the counter. Command “Echoing” actuates control device that ensure illumination of the LED. “TIC Echo” signal delivered by Photo detector and goes to TIC via Pulse shaper to stop counter.

The testing mode ends in generation of a check code corresponding to 20 μs the range is 3000±150 meter. Same way “Test-2” command generates by Converter to operate in the radiation mode and simultaneously generates a check code corresponding to the range of 3000±150 meter to ensure monitoring of its failure in radiation.

(b) Large field Surveillance Mode:

When OLS is switched on Power Supply Panel, one of the MFD is selected to for MASD mode and Leading Control Channel (LCC) on PS-5 is selected as IR., the scanning zone center for 60° (in azimuth) X 10° (in elevation) is decided by the airborne Mission Computer. Here the mirror antenna does four-line scan to cover this area. Total time taken to cover this area is 5 seconds. This zone can be shifted from -10° to +55° with respect to optical axis in elevation plane with the help of absolute altitude of target and manual range input from the throttle. The scan zone can be shifted either to 30° left or 30° right in azimuth plane with the help of scanning zone switches. The scan pattern & area covered by large field surveillance mode is given below in fig. 8 & fig. 9.

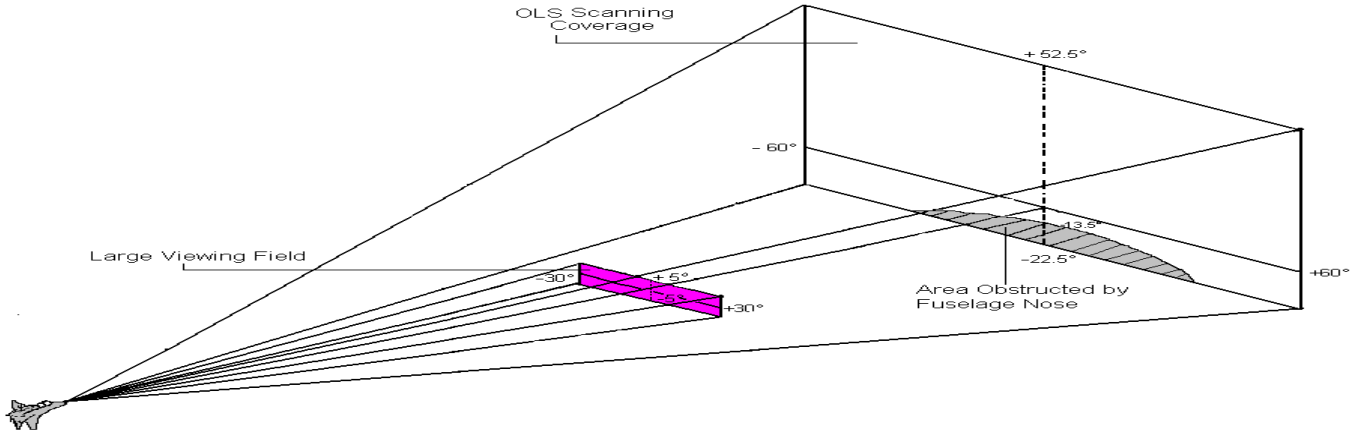


Fig. 8: Scan Pattern in Large Field Surveillance Mode

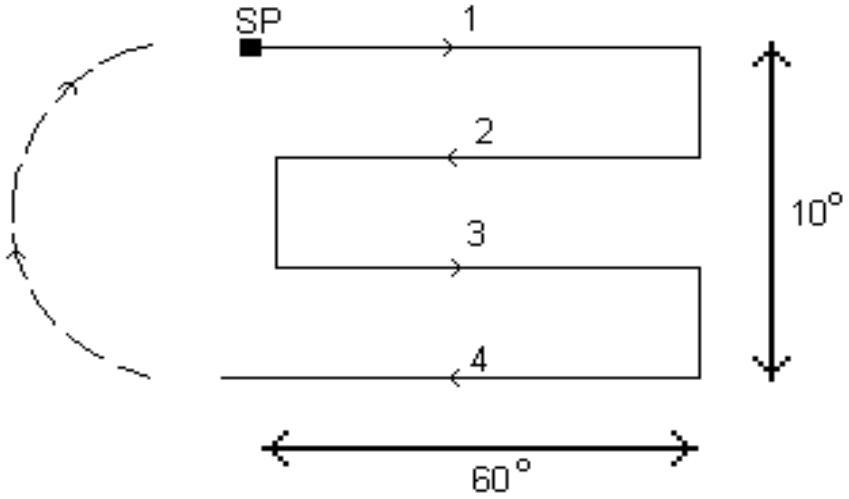


Fig. 9: Area Covered by Large Field Surveillance

(c) Small field surveillance Mode: -

When a target is picked up in big field surveillance mode, the lock on strobe is moved (with DN-106 button) to bring the target in the centre of the strobe and ENTER is pressed (on throttle lever). Now an autonomous search and detection of target in small observation area of 20° (in azimuth) X 5° (in elevation) takes place. Antenna covers this area in two line scan in 01 second. This area can move ± 50° in azimuth plane and from -12.5° to + 57.5° in elevation plane with respect to optical axis. The scan volume actually moves from -20° to +50° in the elevation plane with respect to aircraft axis because optical axis is at -7.5° with respect to aircraft longitudinal axis. The scan pattern & area covered by small field surveillance mode is given in fig. 10 & fig. 11.

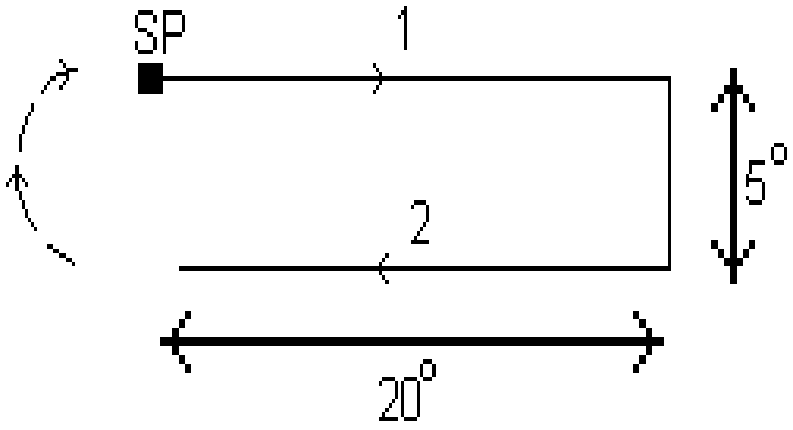


Fig. 10: Scan Pattern in Small Field Surveillance Mode

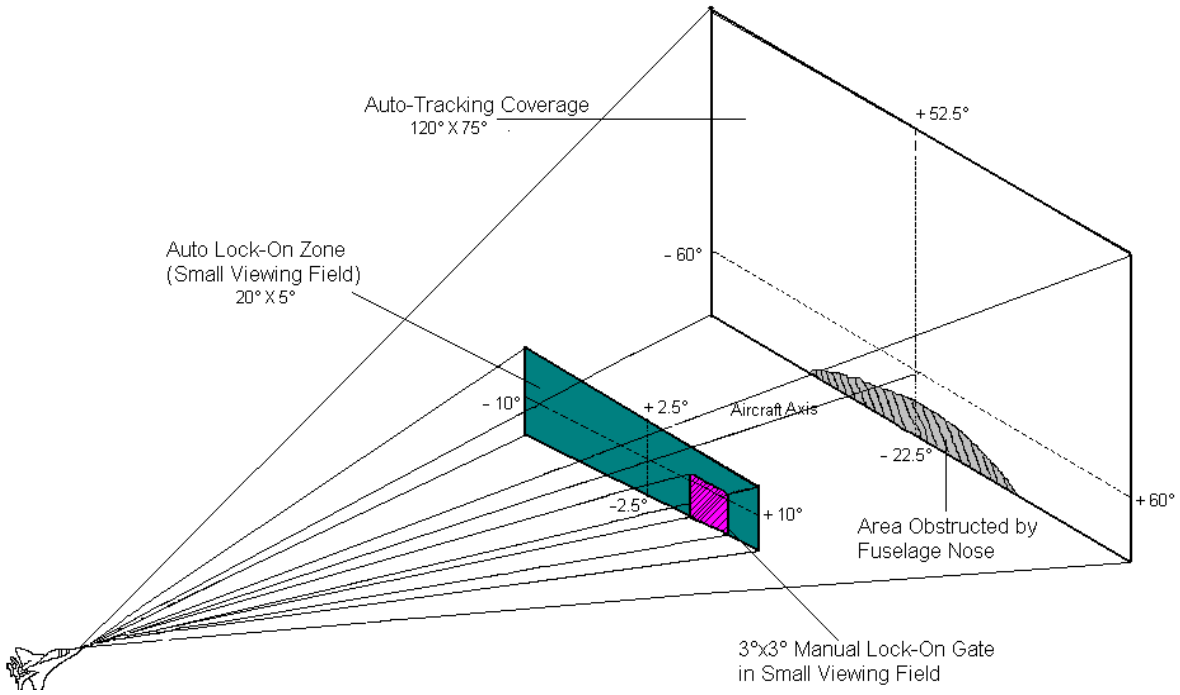


Fig. 11: Area Covered by Small Field Surveillance

(d) Lock On & Tracking Mode:

This mode of OLS operation starts either automatically or manually depending upon the position of LOCK ON AUTO-MAN Multi Function Button (MFB) on PS-5 Panel. When the button MAN selected, the lock on strobe is to be positioned in such a way that the target is in centre of the strobe and the ENTER button on throttle lever is pressed. Here onwards the lock on mode passes through three different stages:-

(i) Firstly, lock on is effected in 3° azimuth and 3° elevation area. Here OLS mirror does not move in elevation at all. There are a total of 64 photo elements arranged vertically, which covers 3° in elevation. To cover 3° in azimuth, a small mirror inside the opto-mechanical assembly is oscillated at the rate of 25 Hz since it is very difficult to move the outer OLS mirror with such a high rate due to its bulkiness. The target is automatically brought to the center of the area with the help of control signal from the electronic block to the outer mirror antenna. As soon as the target is brought to the center of 3° X 3° area, the second phase of lock on starts.

(ii) In this phase of lock-on, the coverage area is reduced to 40' azimuth X 40' elevation. Elevation coverage of the area is done with the help of 14 central photo receivers (out of total 64) without physical movement of the antenna. In azimuth plane 40' is covered by oscillation of the inner small mirror at the rate of 100 Hz. As soon as the target is brought to the centre of 40' X 40' area, the third phase of lock on starts.

(iii) Now, the lock-on area is further reduced to 12' azimuth and 18' elevation. Azimuth plane is covered by oscillating the inner mirror at 100 Hz, whereas elevation plane is covered by 06 central photo receivers (out of the previous 14).

2). Mode of Operation of LRF:

LRF operates in two modes as follows: Modes of operation of LRF is decided by a command received from Mission Computer through electronic unit. Electronic unit in turn gives a command to control unit (25F/02). Control unit generates a Transmitter Trigger Pulse (TTP) depending on the duty or main mode of firing.

(a) Duty mode:

This mode comes into operation when the target range is more than 1600 meters. In this mode, LRF operates with 0.25Hz (One pulse at every 4 second).

(b) Main mode:

LRF Operates in main mode when the target range is less than 1600 meters. LF operates with 2Hz (Two pulse every second).

CONCLUSION

From the study of Optical LASER System we can understand the structure of the system, detailed methodology and functioning of the system.

Optical LASER System is used in the fighter aircraft for detection of target and locking, tracking & measuring the distance of target. Detection, locking & tracking of the target are carried out by infra red (IR) waves and distance of target is measured by LASER beam.

The functioning of the system is based on the conversion of analog signals in to digital signals and conversion of these digital signals in to required information for display to Pilot and recording in FDR.

During my course of study of this project, I have come across the various technical detail of the unit is a complex one which involve mainly three branches of engineering, mechanical ,electrical,electronics. For detection of target we use the complex optics and opto mechanical devices and equipment. Once the target is detected and locked its coordinate bearing information is calculated by a series of complex electronics unit current shapers and video amplifier

SCOPE OF FUTURE STUDY

- There may be some improvement in the technicalities of the unit w.r.t. its size and performance. The 05 no. of video amplifier may be combined in one unit and thus reducing the complexity and size.

- The unit works in big field for 60x10 viewing area this can be increase to 180x 20 which further improves its detecting range and capability.

- The cooling systems used for laser ranger and opto mechanical block are the two different natures and two systems are separately laid for them. A new system may be laid to club them and provide a single cooling system for both.

- The laser ranger and opto mechanical block used separate power supply. Both power supply can be clubbed together further in future development the power for whole OLS unit may be drawn from the main power source of the aircraft.

- As the system involves a nos. of bulky components, optical, electrical & electronic components/ parts and mechanical parts. The module can be designed / circuit can be modified with small/ miniature components.

- As the 36E of the system involves Fine Wiring Technology, RAM & ROM and various PCBs, which uses very thin insulated wire through which connections is done between various points on PCB, As the wiring through Fine Wiring Technology forms a net of thin insulated wires on one side of PCB it is very difficult to find out if

wires broken or short circuited For this multilayer's PCB can be designed so that fine wiring can be eliminated form this module processor.

- As the system consists of PCBs with heavily dense components, the PCBs can be designed / circuit can be modified using surface mount components of high packing density.

- As the system consists of numbers of PCBs with heavily dense in the chassis, the PCBs can be designed / circuit can be modified using integration of 2 or more PCBs together.

REFERENCE

1) Operating & Testing Manual of OLS & Optical & Mechanical Unit (OMU)

2) Operating & Testing Manual of LRF & Transmitter Block

3) Operating & Testing of Power Supply Unit

4) www.hal-india.com & www.wikipedia.com.