IRS-1C

Data Users Handbook

National Remote Sensing Agency
(Dept. of Space, Govt. of India)
Hyderabad, India

IRS-1C DATA USERS HANDBOOK

NATIONAL REMOTE SENSING AGENCY
(DEPARTMENT OF SPACE, GOVERNMENT OF INDIA)
HYDERABAD

DOCUMENT CONTROL AND DATA SHEET

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CONTENTS

Section		Page
5. DATA DISTRIBUTION		

APPENDICES

LIST OF FIGURES

LIST OF TABLES

1. INTRODUCTION

1.1 INDIAN SPACE PROGRAMME

1.1.1 SCOPE

The Indian Space Programme has the goal of harnessing space technology for applications in the areas of communications, broadcasting, meteorology and remote sensing. As a part of this programme it has acquired state-of-the-art capabilities in development and establishment of satellite based operational remote sensing application system.

1.1.2 INDIAN REMOTE SENSING PROGRAMME

Remote Sensing is an important part of the Indian Space Programme and the Department of Space (DOS), Govt. of India, is the nodal agency for implementation of the National Natural Resources Management System (NNRMS) in collaboration with the user agencies. The important milestones crossed so far in achieving an indigenous end-to-end capability are :

Bhaskara-1 and 2 : These were experimental remote sensing satellites launched in June 1979 and November 1981 respectively. The payload consisted of TV cameras and Radiometers for earth observation.

IRS 1A/1B : These are the operational, first generation remote sensing satellites with two Linear Imaging and Self Scanning sensors (LISS-I and LISS-II) onboard for providing data in four spectral bands (visible and near infra red regions) with resolutions of 72.5m and 36.25m. These satellites were launched in March 1988 and August 1991 respectively.

IRS-P2: This satellite was launched in October 1994 on PSLV-D2, a launch vehicle, developed by the Indian Space Research Organisation (ISRO), from Shriharikota in India. IRS-P2 carries a modified LISS camera. The data is being used to provide products similar to IRS-1A/1B LISS-II products.

IRS-P3: This satellite is scheduled to be launched on PSLV- D3. IRS-P3 will carry two imaging sensors viz., Wide Field Sensor (WiFS) and Modular Opto-electronic Scanner (MOS) and sensor for X- ray astronomy.

Simultaneously, infrastructure for training, application and data product generation from several contemporary satellites have also been established during the past two decades. IRS-1A/1B continue to provide valuable space based remote sensing data on the country's natural resources and thus have become the mainstay of the NNRMS. IRS-P2 has also joined the IRS system, enhancing the data dissemination capacity.

IRS-1C : Encouraged by the past experience, the DOS took up the ambitious challenge of developing the next generation satellite namely IRS-1C with improved sensor and coverage capabilities to meet the growing application needs.

Many applications like crop acreage and yield estimation, drought monitoring and assessment, flood mapping, wasteland mapping, ocean/marine resources survey, urban mapping, mineral prospecting, forest resource survey etc., have become an integral part of the resources management system in the country. The Integrated Mission for Sustainable Development

(IMSD), launched in June 1992, now covers 157 districts which have been identified for generation of action plans for development using mainly IRS data.

IRS-1C services are planned to have an international dimension. Operation of the payload over other stations outside India is also envisaged.

1.2 MISSION OVERVIEW

1.2.1 INTRODUCTION

The popularity of satellite based remote sensing has created a need for providing data with better resolution, coverage and revisit. IRS-1C is conceived to meet these demands. Two satellites, IRS-1C and IRS-1D, with similar payloads, each with a mission life of three years, are planned.

The principal components of the mission are:

* a three axis stabilised polar sun synchronous satellite with three sensors
* a ground based data reception, recording and processing system
* ground system for in-orbit satellite control.
* hardware/software elements for the generation of user oriented data products, data analysis and archival.

1.2.2 MISSION OBJECTIVES

The objectives of the mission are:

* to design, develop, launch and operate a state-of-the-art three-axis body stabilised satellite providing continuous space based remote sensing services to user community with enhanced resolution and capability compared to IRS-1A and IRS-1B.
* to establish and operate ground based systems for data reception, recording, processing, generation of data products, analysis, archival and mission control facilities.
* to develop new areas of user applications to take full advantage of the enhanced resolution and capability of IRS-1C/1D sensors.

1.3 ORGANISATION OF THE HANDBOOK

The IRS-1C Data User's Handbook is being published to provide essential information to the users on IRS-1C satellite data.

The main body of the handbook covers the logical chain of activities involved in data acquisition, generation and distribution.

Section 2 describes the IRS-1C Space Segment which includes payload, orbit and coverage.

Section 3 deals with the various aspects of IRS-1C Ground Segment such as Mission Operations and Control Centre, Data Acquisition and Archival System and Data Products Generation System.

Section 4 provides detailed description of IRS-1C Referencing Scheme and the various types of products that will be made available to the users.

Sections 5 provides describes the procedure for ordering and obtaining data products.

Appendix-I gives the list of product codes.

Appendix-II gives the list of Indian districts, their code and the class to which they belong.

A list of acronyms used in the handbook is provided as Appendix-III.

This handbook will be revised periodically to provide updated information.

2. SYSTEM DESCRIPTION

2.1 SYSTEM OVERVIEW

The IRS-1C is a three axis body stabilised satellite. It will have an operational life of three years in a polar, sun synchronous orbit at a height of 817 Km.

The satellite payload consists of three sensors.

(1) Panchromatic camera (PAN)

The Panchromatic camera will provide data with a spatial resolution of 5.8m and a ground swath of 70Km. It will operate in the 0.50-0.75 microns spectral band. This camera can be steered upto ± 26deg (steerable upto ± 398 Km across the track from nadir) which in turn increases the revisit capability to 5 days.

(2) Linear Imaging and Self Scanning Sensor (LISS-III)

The LISS-III sensor will provide multispectral data collected in four bands of the visible, near infra-red (V,NIR) and short wave infra-red (SWIR) regions. While the spectral resolution and swath in the case of visible (two bands) and NIR (one band) regions will be 23.5m and 141 Km. respectively, they will be 70.5m and 148 Km. for the data collected in SWIR region.

(3) Wide Field Sensor (WiFS)

WiFS will collect data in two spectral bands and will have a ground swath of 810 Km. with a spatial resolution of 188.3m.

The satellite will be equipped with an onboard tape recorder, capable of recording limited amount of specified sensor data. Operation of each of the sensors can be programmed. The payload operation sequence for the whole day can be loaded daily onto the onboard command memory when the satellite is within the visibility range.

The ground segment will consist of :

i. A Telemetry Tracking and Command (TTC) segment comprising of a TTC network to provide optimum satellite operations and a Mission control centre for mission management, spacecraft operations and scheduling

ii. An Image segment comprising of data reception, data processing, product generation systems and data dissemination centre.The overview of IRS-1C mission is shown in Figure 2.1.1.

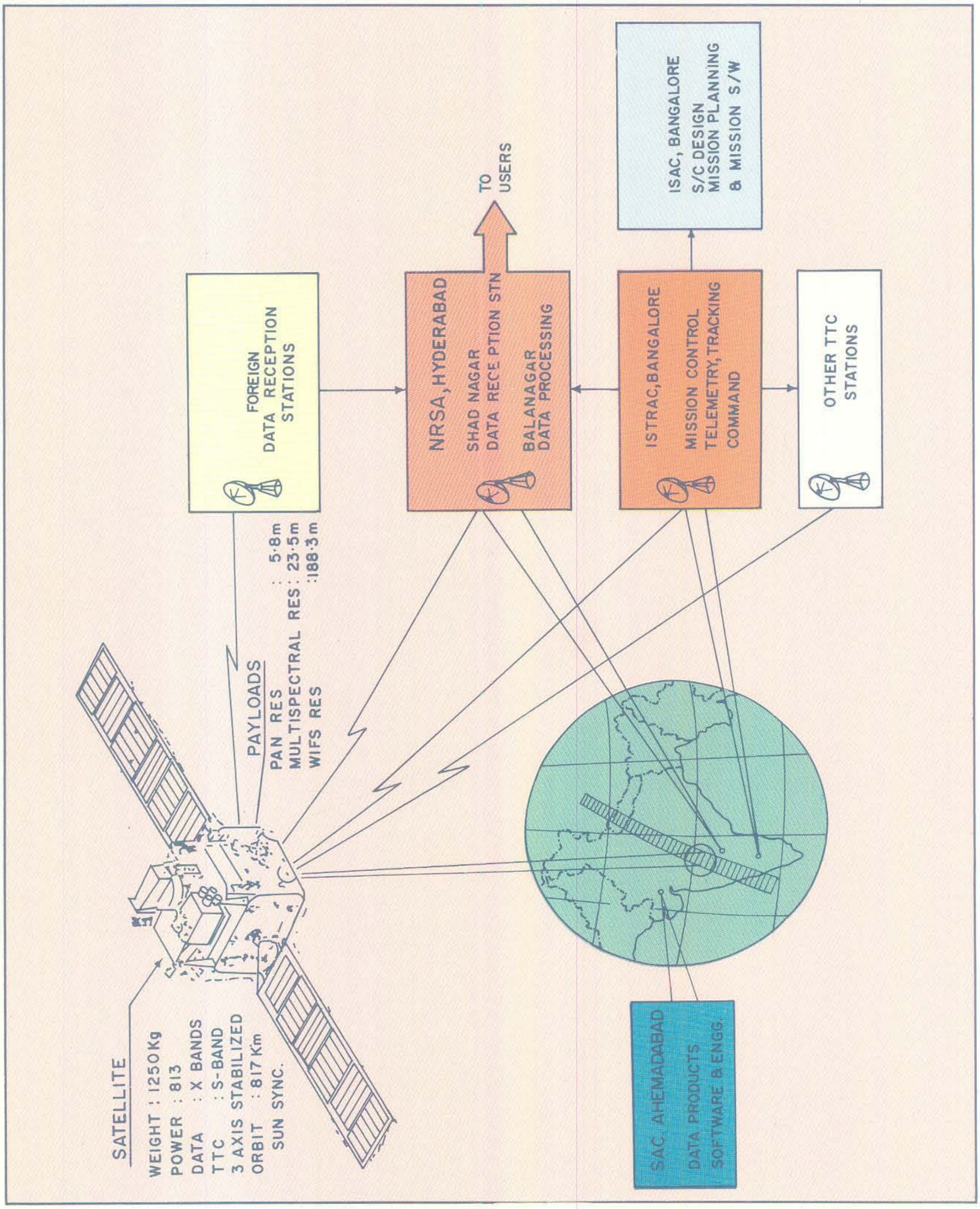


Figure 2.1.1 Overview of IRS-1C mission

2.2 SPACE SEGMENT

The space segment carries out the following functions :

- Images the earth in all the required spectral bands.
- Formats the payload sensor data and transmits to ground stations in X-band and also records the video data for later transmission.
- Provides necessary power (with a margin) for mainframe and payload subsystems in all operating conditions
- Provides attitude stability required for imaging
- Provides housekeeping information for monitoring the satellite health and accepts telecommands to control the spacecraft.

The structure of the spacecraft consists of :
Main platform
Payload platform.

The main platform consists of four vertical panels and two horizontal decks supported on a central load bearing cylindrical shell of 930 mm diameter and 1123 mm height. The bottom of the cylinder is attached to an interface ring which interfaces with the launch vehicle. The vertical panels and horizontal decks carry the major mainframe subsystem packages. The Sunside and anti-Sunside panels additionally support solar arrays and the power transfer assemblies. The earth viewing panel carries the payload data transmission antenna, the TTC antenna and Sun sensors.

The payload platform accommodates the PAN, LISS-III and WiFS cameras. In addition, it accommodates Earth sensors and Star sensors. A Carbon Fibre Reinforced Plastic (CFRP) monocoque cylinder of 930 mm diameter and 370 mm height separates these two platforms and provides thermal isolation to minimise thermal distortion effects on imaging.

The PAN payload has a capability to tilt upto an angle of ± 26 deg in the direction of pitch. A Payload Steering Mechanism (PSM) supporting the PAN camera enables this rotation. The PSM is initially held by a hold down mechanism during launch. Later, it is released by activating a pyrocutter by a command.from the ground.

Four Reaction Control System (RCS) propellant tanks made of titanium of 390 mm diameter are mounted on either side of a 30.7 mm thick stiffened honeycomb deck of 875 mm diameter which is fixed inside the main cylinder.

The thermal control system maintains the temperature of different subsystems within specified limits. It employs semi-active and active elements like heaters and temperature controllers in addition to passive elements like paints, multi layer insulation blankets and optical solar reflectors.

The power requirements of IRS-1C are met by six deployable solar panels (size 1.1 m x1.46 m each). Three panels are mounted on the Sun side and three are mounted on the anti Sun side. The panels have a capacity to generate 813 W of power at EOL (End Of Life) at normal incidence. Besides the Sun tracking panels, two batteries of twenty eight cells with a capacity of 21 AH (Ampere Hours) are provided to support peak power requirements and power during eclipse.

The TTC system is configured to work in S-band. It comprises of telemetry and telecommand subsystems and a transponder.

The telemetry system collects the house keeping data from each subsystem and then formats and modulates it on the subcarrier. There are two formats, viz., dwell and normal. Dwell mode.and normal mode formats can be simultaneously received. An onboard storage facility of 2.75 million bits exists for recording the house keeping data of one orbit period or sampled data in 1:5 ratio in sampled mode for four orbits period. The normal telemetry rate is 512 bits per second (bps) while the playback data from storage is at 6.4 Kbps. Telemetry system except for storage has full redundancy. The telemetry sytem also houses another storage facility for recording raw Star sensor data for a period of 25.6 minutes.

The telemetry data is transmitted on two Phase Shift Key (PSK) subcarriers of 25.6 KHz and 128 KHz. The normal telemetry is modulated on 25.6 KHz subcarrier, while the 128 KHz subcarrier is used for playback data or dwell data or Star sensor data.

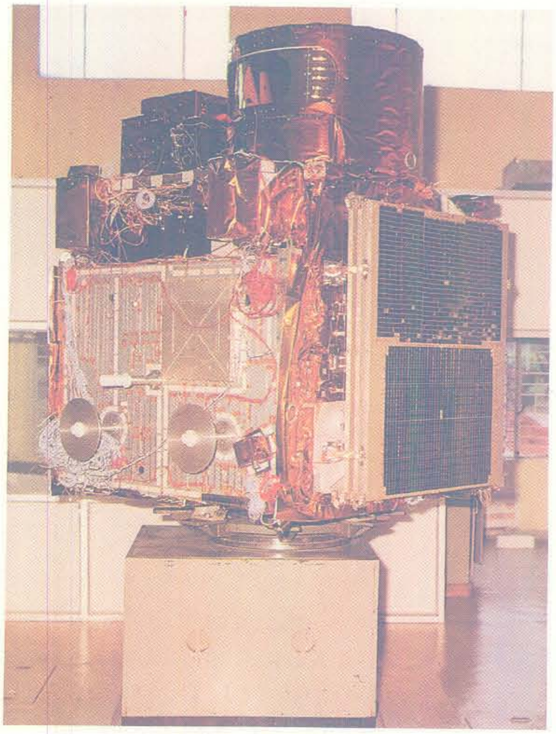
The telecommand system employs a shortened B-C-H code for command reception. It provides time tag command execution facility with edit, block execution and memory error detection features. The time tag facility permits execution of 255 commands per decoder. TC supports auto commanding for autodeployment and safemode operations. It also houses programmable and fixed duration timers to control the operation of payload and data handling system. It provides special logics to configure the payload and data handling system for various operational modes.

The transponder serves to transmit housekeeping data, receive telecommand signals, demodulate ranging tones and retransmit it to ground with a fixed turn around ratio of 240/221.

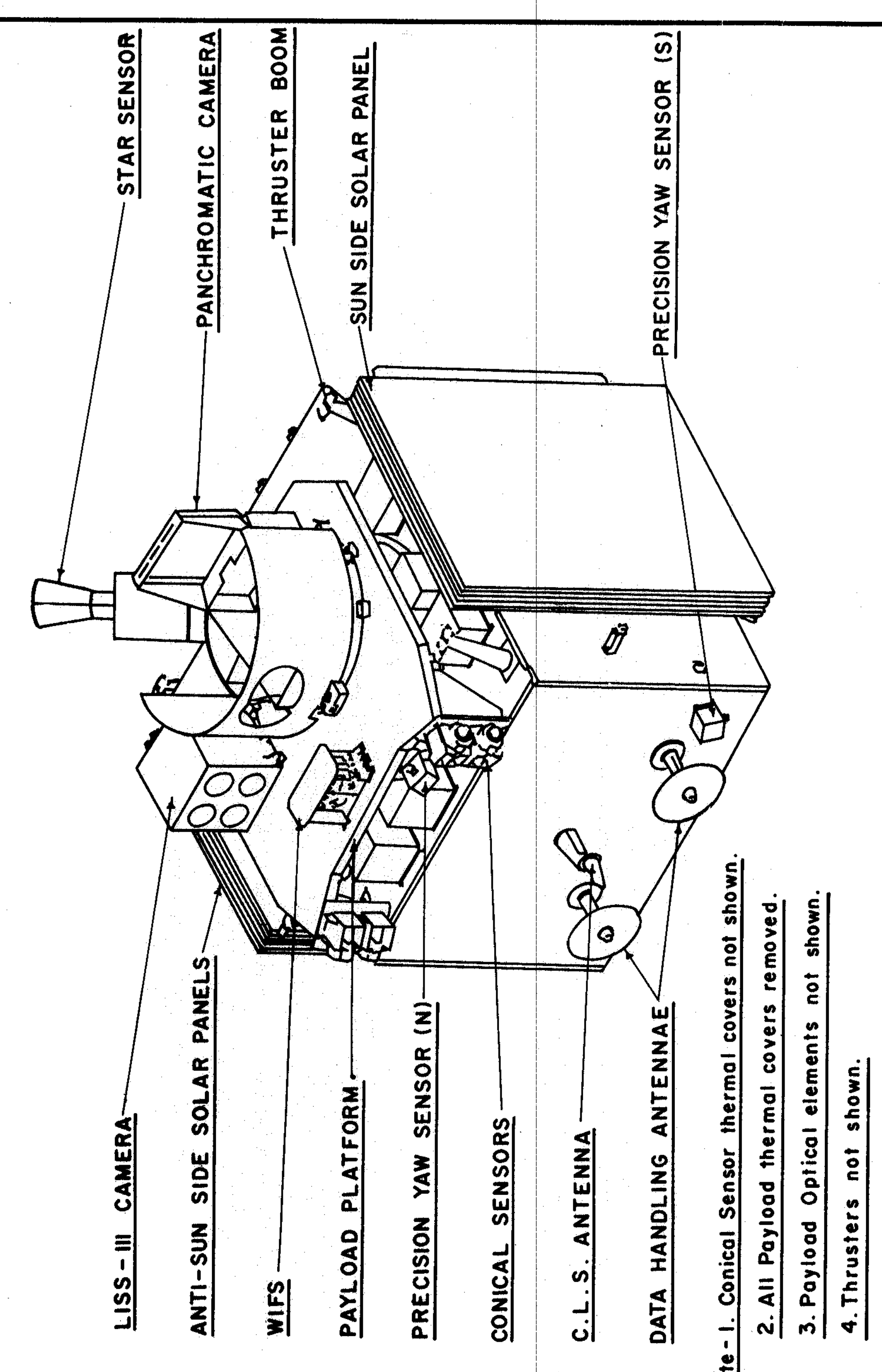
The Attitude and Orbit Control System (AOCS) for IRS-1C is configured to achieve three axis body stabilisation of the spacecraft in Sun synchronous orbit. The AOCS system is basically configured around two systems, one redundant to the other. Each system in turn consists of a processor based system and a hardware based system as a back up. The AOCS system is associated with necessary sensors and actuators to carry out the control functions. All the three axes are controlled using actuators, reaction wheels, magnetic torquers and thrusters. The attitude control electronics package generates control signals for these actuators depending upon the attitude errors sensed by Earth sensors, Gyros and Sun sensors. The system provides for initial three axis acquisition, in-orbit three axis control and orbit control.

The overall specifications of the Observatory are given in Table 2.2.1.

The isometric view of IRS-1C spacecraft (Stowed mode) is as shown in Figure 2.2.1 The disassembled view of IRS-1C spacecraft is shown in Figure 2.2.2.



IRS-1C satellite



Note - 1. Conical Sensor thermal covers not shown.
2. All Payload thermal covers removed.
3. Payload Optical elements not shown.
4. Thrusters not shown.

Figure 2.2.1 Isometric view of IRS-1C spacecraft (Stowed mode)

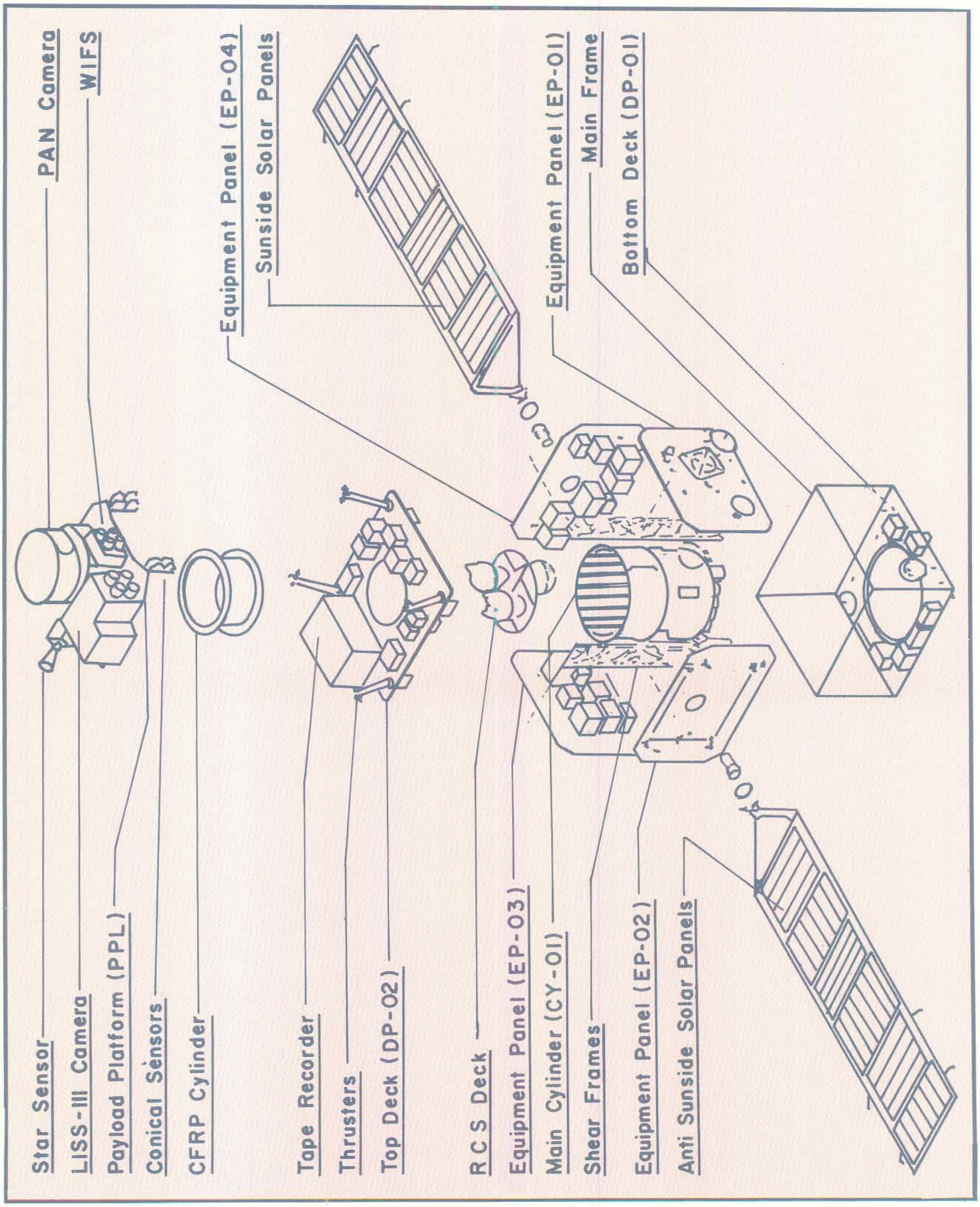


Figure 2.2.2. Disassembled view of IRS-1C spacecraft

Table 2.2.1 Specifications of Space Segment

TYPE	:	Three axis, body stabilised Remote Sensing Satellite		
ORBIT	:	Polar, Sun synchronous ,817 Km altitude with equatorial crossing time of 10.30 A.M., in descending node		
REPETIVITY	:	341 orbits / 24 days		
REVISIT CAPABILITY	:	5 Days		
MISSION LIFE	:	Three years		
<u>MECHANICAL CONFIGURATION</u>				
STRUCTURE	:	Aluminium and Aluminium Honeycomb		
WEIGHT	:	1250 Kg		
<u>THERMAL CONTROL</u>				
COMPONENTS	:	Passive control using tapes, paint, Optical Solar Reflectors (OSR), Multi Layer Insulation (MLI) blankets and semi-active, active control using proportionate temperature controllers and heaters		
TEMPERATURE	:	20±3 deg Centigrade for payload ; 2 ±2deg Centigrade for batteries 0 to 40 deg Centigrade for electronic packages		
<u>PAYLOADS</u>				
TYPE	:	Optical sensors (Charged Coupled Devices (CCD) linear array)		
NO. OF SENSORS	:	Three -	i)	PAN
			ii)	LISS-III
			iii)	WiFS
SPECTRAL BANDS	:	PAN		0.50 -0.75 μ
		LISS-III	Band 2	0.52 - 0.59 μ
			Band 3	0.62 - 0.68 μ
			Band 4	0.77 - 0.86 μ
			Band 5	1.55 - 1.70 μ

Table 2.2.1 Specifications of Space Segment (continued)

	WiFS	Band 3	0.62 - 0.68 μ
		Band 4	0.77 - 0.86 μ
SPATIAL RESOLUTION :	PAN	5.8 m	
	LISS-III	23.5 m for B2,B3,B4 ; 70.5 m for B5	
	WiFS	188.3 m	
SWATH :	PAN	70 Km (nadir); 90 Km. (at maximum look angle)	
	LISS-III	141 Km for B2,B3,B4 ; 148 Km for B5	
	WiFS	810 Km	
ENCODING :	PAN - 6 Bits ; LISS-III - 7 Bits ; WiFS - 7 Bits		

DATA HANDLING :

	PAN	LISS-III
DATA RATE	84.903 Mbps	42.4515 Mbps
MODULATION	QPSK	QPSK
FREQUENCY	8150 MHz	8350 MHz
POWER	40 Watts	40 Watts
BEACON FREQUENCY	8255 MHz	
POWER	100 milliWatts	

ONBOARD TAPE RECORDER

NUMBER OF STREAMS :	One
INPUT/OUTPUT DATA RATE :	42.4515 Mbps
RECORDING CAPACITY :	62 G b (24 minutes)
TRANSMISSION :	Through LISS-III chain

POWER :

SOLAR ARRAY POWER GENERATION CAPACITY AT EOL :	813 Watts
BATTERY :	2 batteries of 21 AH each

Table 2.2.1 Specifications of Space Segment (continued)

ATTITUDE AND ORBIT CONTROL

ATTITUDE SENSORS	:	Four PI Sun sensors, five sun sensor, analog yaw sensors, precision yaw sensors, conical scanner earth sensors, digital yaw sensor, twin slit sun sensor, star sensor, solar panel sensor, magnetometers, pressure sensors, temperature sensors, dynamically tuned gyros
ACTUATORS	:	Four Reaction wheels ; Two Magnetic torquers; Sixteen One Newton Hydrazine thrusters , One Eleven Newton Hydrazine thruster
POINTING ACCURACY	:	ROLL ± 0.15 Deg ; PITCH ± 0.15 Deg ; YAW ± 0.2 Deg
DRIFT	:	$3x10^{-4}$ deg/sec

TELEMETRY,TRACKING AND COMMAND

A.	TELEMETRY DATA	Real time	512 bps
		Dwell	512 bps
		Playback (Storage 1)	6.4 Kbps
		Star Sensor (Storage 2)	6.4 Kbps
	SUBCARRIER	Real time	25.6 KHz
		Dwell/Playback/Star sensor	128 KHz
	MODULATION	Pulse Code Modulation/ Phase Shift Keying/ Phase Modulation (PCM/PSK/PM)	
	STORAGE (HK) (HOUSE KEEPING)	Capacity	2.75 Mb
		Data type	Sampled (1:5) or continuous
	STORAGE (STAR SENSOR)	Capacity	512 KB
		Data type	Raw
B.	TELECOMMAND :	No. of ON/OFF commands	704
		No. of Data commands	50
		Command Bit rate	100 bps

Table 2.2.1 Specifications of Space Segment (continued)

MODULATION	:	Pulse Code Modulation/ Frequency Shift Keying/ Frequency Modulation/Pulse Modulation (PCM/FSK/FM/PM)	
FSK SUB-CARRIER FOR ONE	:	5.555 KHz	
FSK SUB-CARRIER FOR ZERO	:	3.125 KHz	
No. OF TIME TAG COMMANDS	:	255 per Decoder	
PROBABILITY OF ERRONEOUS COMMAND EXECUTION	:	$1.8X10^{-42}$	
PROBABILITY OF COMMAND REJECTION	:	$0.98 X 10^{-13}$	
TRANSPONDER	:	Uplink frequency	2028.78 MHz
		Down frequency	2203.2 MHz
		Turn Around Ratio	240/221
		S-Band tone ranging	Max Tone 100KHz two way Doppler

2.3 PAYLOAD AND DATA HANDLING SYSTEM

2.3.1 PAYLOAD SYSTEM

2.3.1.1 PAN Camera

Optics and electronics

The Panchromatic camera uses reflective optics alongwith 4096 element CCD linear array (7 micron x 7 micron) for imaging. A special arrangement comprising of an isoceles prism reflector is used for covering the full swath of 70Km. Each detector has separate interference filters and 4 Light Emitting Diodes (LEDs) along with a cylindrical lens. Two LEDs are for optical biasing and two are for inflight calibration of the sensor.

Four selectable gains are provided for PAN camera. The payload performance parameters are specified in the Table 2.3.1

S.No	PARAMETER		SPECIFICATION
1.	Spatial resolution (m)(at Nadir)		5.8
2.	A)	Swath (Km)	70
	B)	Swath Steering Range (Deg)	± 26
		Step size (Deg)	± 0.09
		Repeatability (Deg)	± 0.1
3.	Spectral band (micron)		0.50 - 0.75
4.	Camera Square Wave Response (SWR) (at Nyquist frequency)		> 0.20
5.	Quantisation (Bits)		6
6.	Signal to Noise Ratio (SNR) (at saturation radiance)		> 64
7.	Saturation radiance (mw/cm^2-str-micron)		47
8.	Integration time(ms)		0.8836
9.	Data rate(Mbps)		84.903

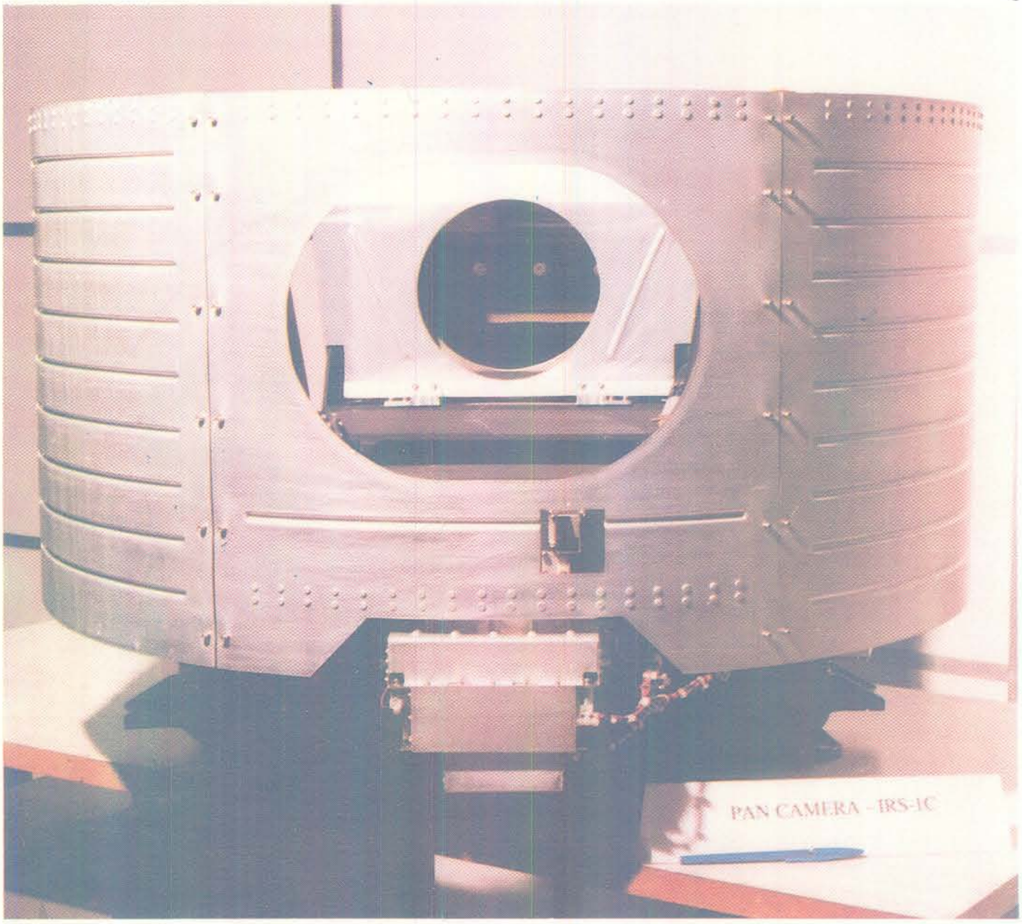
Table 2.3.1 Specifications of PAN camera

Inflight calibration

The detector characteristics that are evaluated on the ground are Light Transfer Characteristics (LTC), spectral responsivity, dark current, dynamic range and shading characteristics. Besides the main detectors, optical components like lenses and filters are thoroughly performance tested on ground and extensive calibration data is generated on ground for radiometric correction.Regular inflight calibration helps to study the response degradation of the CCD output. The inflight calibration of the camera will be carried out using LEDs. LEDs have the advantage of low power consumption, low thermal dissipation and fast response time. The scheme envisages the calibration of CCDs excluding optics. LEDs are operated in pulse mode at higher currents resulting in higher intensities.

A calibration cycle comprises of 2048 lines. The time taken for one calibration cycle for PAN camera is approximately 1.8sec. The LEDs are operated at pulsed mode and the

duration for which the LEDs are 'ON' is varied in specific steps. The CCD detector integrates the light falling on it during one readout period. Six non-zero exposure levels spanning the full dynamic range are provided for each detector.



PAN camera

2.3.1.2 LISS-III Camera

Optics and electronics

LISS-III operates in four spectral bands. There is a separate optics and detector array for each band. Three bands (B2, B3 and B4) are in the visible and near infrared region. B5 is in short wave infrared region. Since the first three bands of LISS III are in the same spectral region as IRS-1A/1B/P2 sensors, the same nomenclature is continued. Bands B2,B3 and B4 of IRS-1C are therefore identical to that of IRS-1A/1B/P2.

The camera uses refractive optics. The collecting optics consists of eight refractive lens elements with interference filter in front. A linear array of 6000 elements of CCDs is used for visible and infra-red bands. It has a pixel size of 10 micron by 7 micron. It has separate readouts for odd and even pixels on two channels. Each detector has its own detector drive electronics. Band 2,3 and 4 have separate video chains.

Band 5 consists of a 2100 element linear CCD array (7 modules of 300 pixels) with a pixel size of 30 micron by 30 micron. Odd and even pixels are staggered by 52 microns in the along track direction. The device will be operated at -10 deg C or at -5 deg C with a temperature stability of ±0.1 deg C.

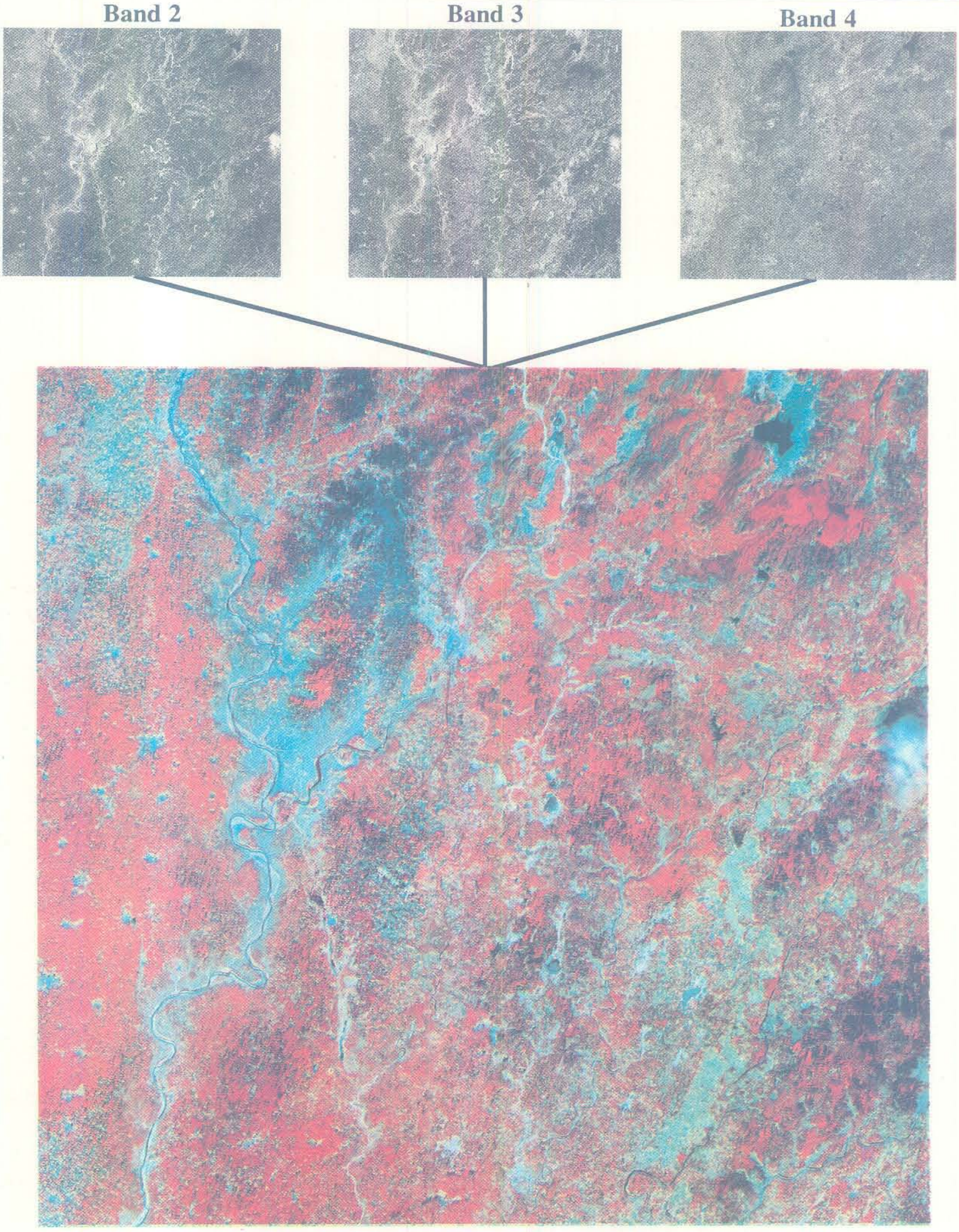
Four independently selectable gains are provided for each band of LISS III. The payload performance parameters are given the Table 2.3.2.

Inflight calibration

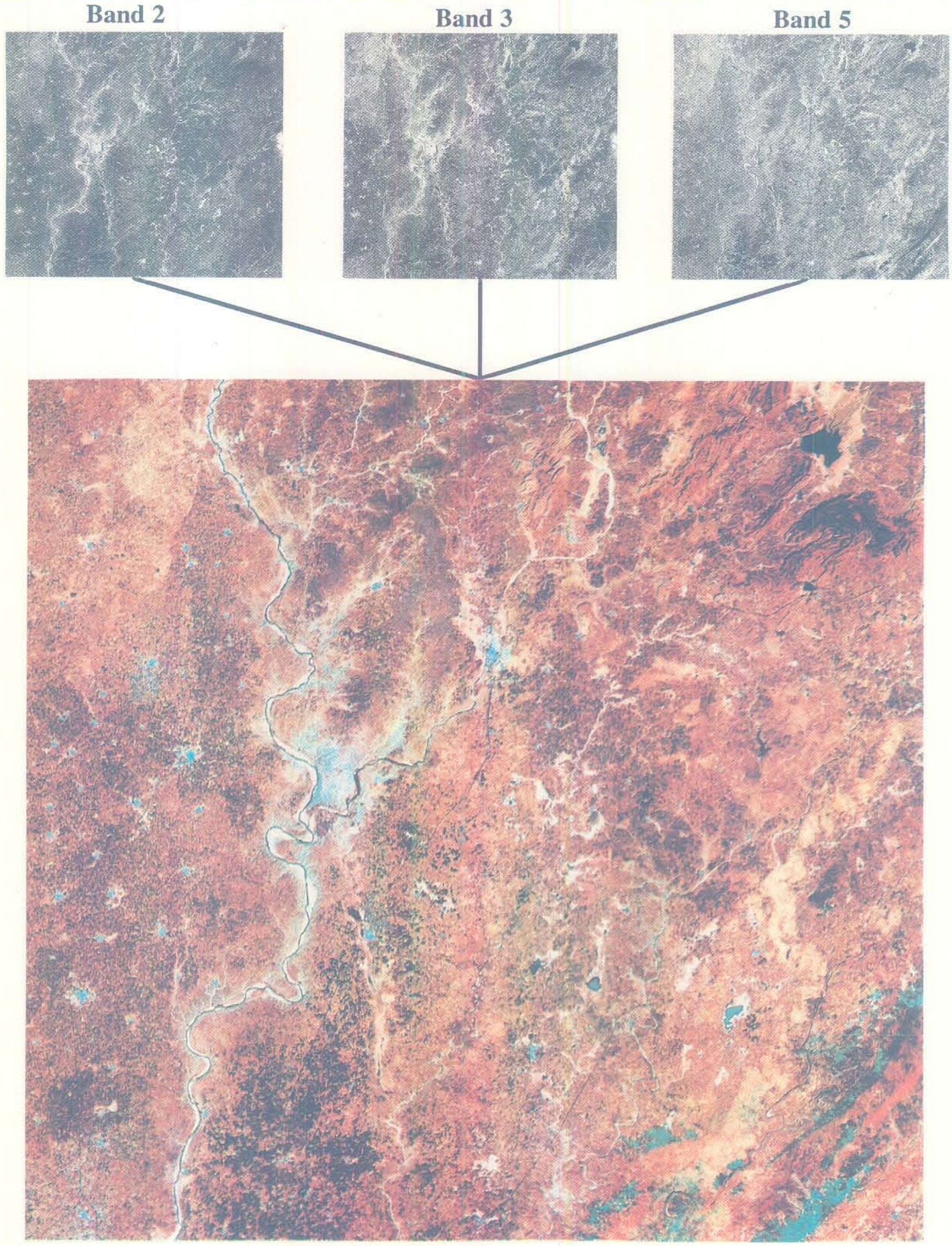
The inflight calibration of the camera is carried out using LEDs. Six Non zero exposure levels spanning the dynamic range are provided for each detector. Four LEDs are used for illumination. Two LEDs operate at a time to cover half the length of CCD. The LEDs are operated in pulsed mode and the duration during which the LEDs are 'ON' is varied in specific steps. Each LED has a cylindrical lens to maximise the

SL NO	PARAMETER	SPECIFICATION	
1.	Spatial resolution (m)	B2,B3,B4	23.5
		SWIR-B5	70.5
2.	Swath (Km)	B2,B3,B4	141
		B5	148
3.	Spectral band (microns)	B2	0.52 - .059
		B3	0.62 - 0.68
		B4	0.77 - 0.86
		B5	1.55 - 1.70
4.	Camera Square Wave Response (SWR)	B2	>40
		B3	>40
		B4	>35
		B5	>30
5.	Quantisation (bits)	7	
6.	Signal to Noise Ratio (SNR) (at saturation)	>128	
7.	Saturation Radiance		
	(mw/cm^2-str-micron)	B2	29 ± 1.5
		B3	28 ± 1.5
		B4	28 ± 1.5
		B5	3.25 ±. 25
8.	Integration time (ms)	B2,3 and 4	3.5528
		B5	10.6584
9.	Data rate (Mbps)	B2,3 and 4	35.7904
		B5	1.3906
10.	Band to Band registration (pixels)	B2,3,4	± 0.25

Table 2.3.2 Specifications of LISS-III Camera

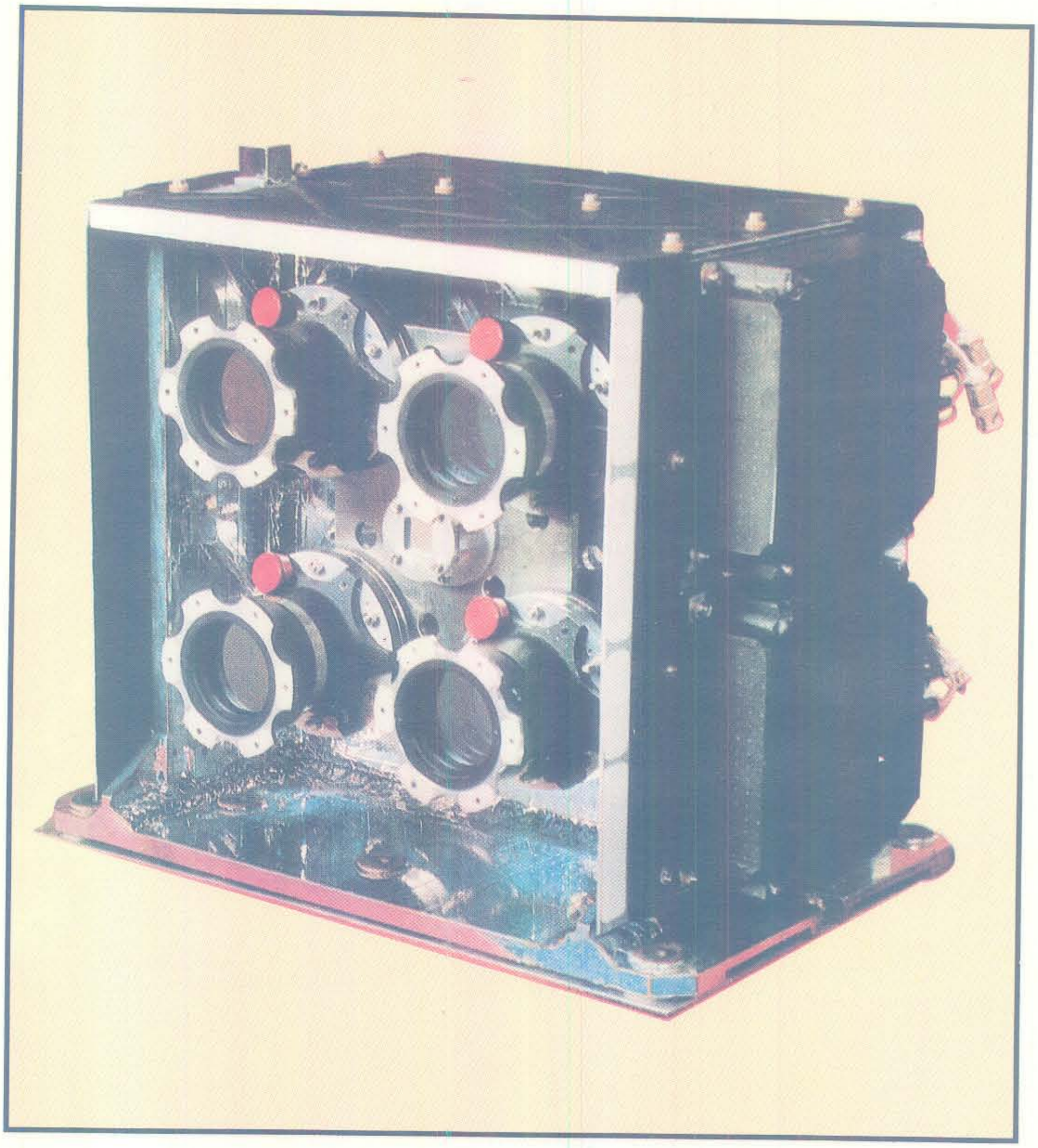


Simulated LISS-III FCC image (234)



Simulated LISS-III FCC image (235)

intensity. For Band-5, the LEDs have very small angular divergence. The CCD detector integrates the light falling on it during one readout period. A calibration cycle comprises of 2048 lines. The time taken for one calibration cycle of LISS-III is 7.3 seconds. The Band-5 calibration data is multiplexed with data of other bands.



LISS-III camera

2.3.1.3 WiFS Camera

Optics and electronics

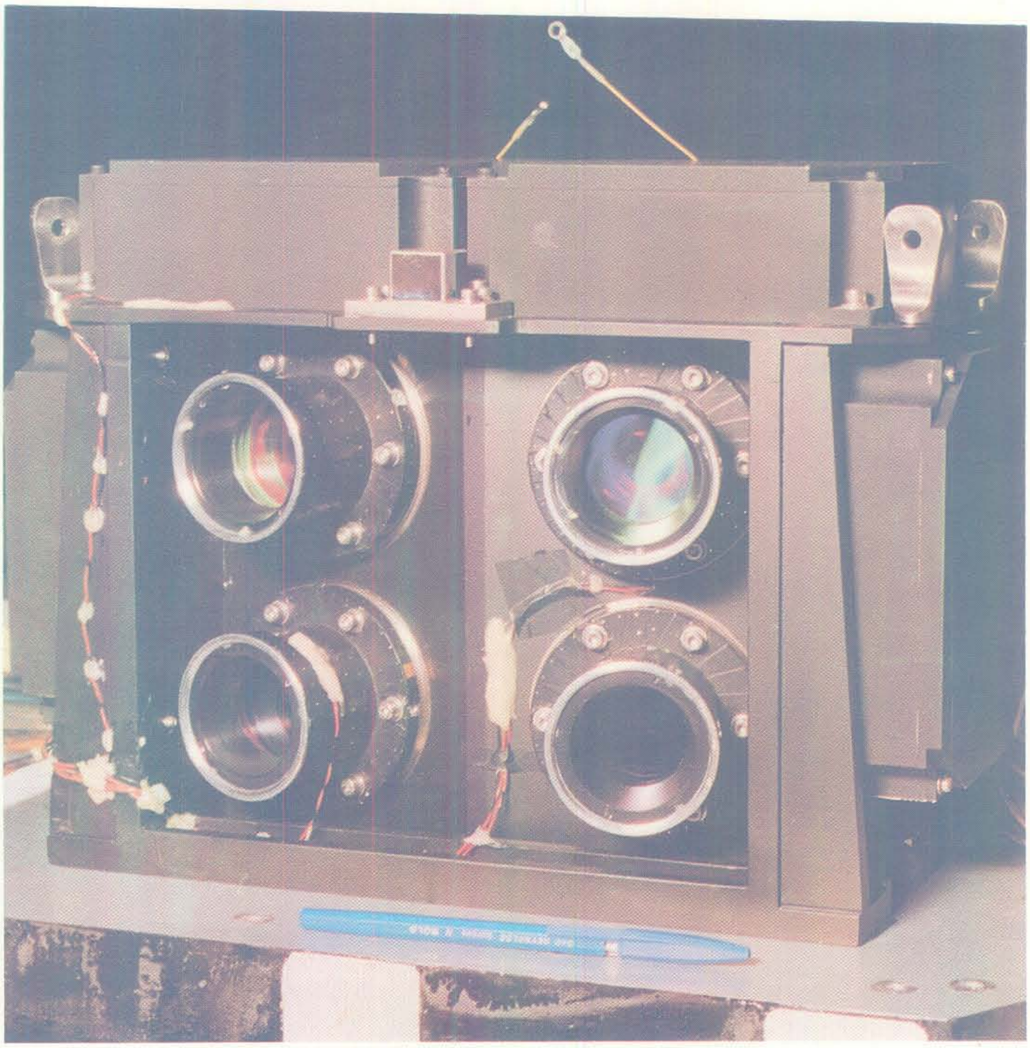
WiFS camera consists of two bands and are named as B3 and B4, because these bands are similar to Band-3 and Band-4 of IRS-1A/1B/P2. The total swath is covered using two optical heads ie., two lenses and two CCDs are used per band. They are mounted at an angular separation of 26 deg generated by a single Electo Optic Module (EOM). WiFS camera uses refractive collecting optics consisting of eight refractive lens elements with interference filter and neutral density (ND) filter in the front. A 2048 element linear array CCD with a pixel size of 13 micron by 13 micron is used. It has separate readouts for even and odd pixels on two channels.

The data for each device will be readout four times during the line scan time period . Only one out of every four readouts is transmitted.

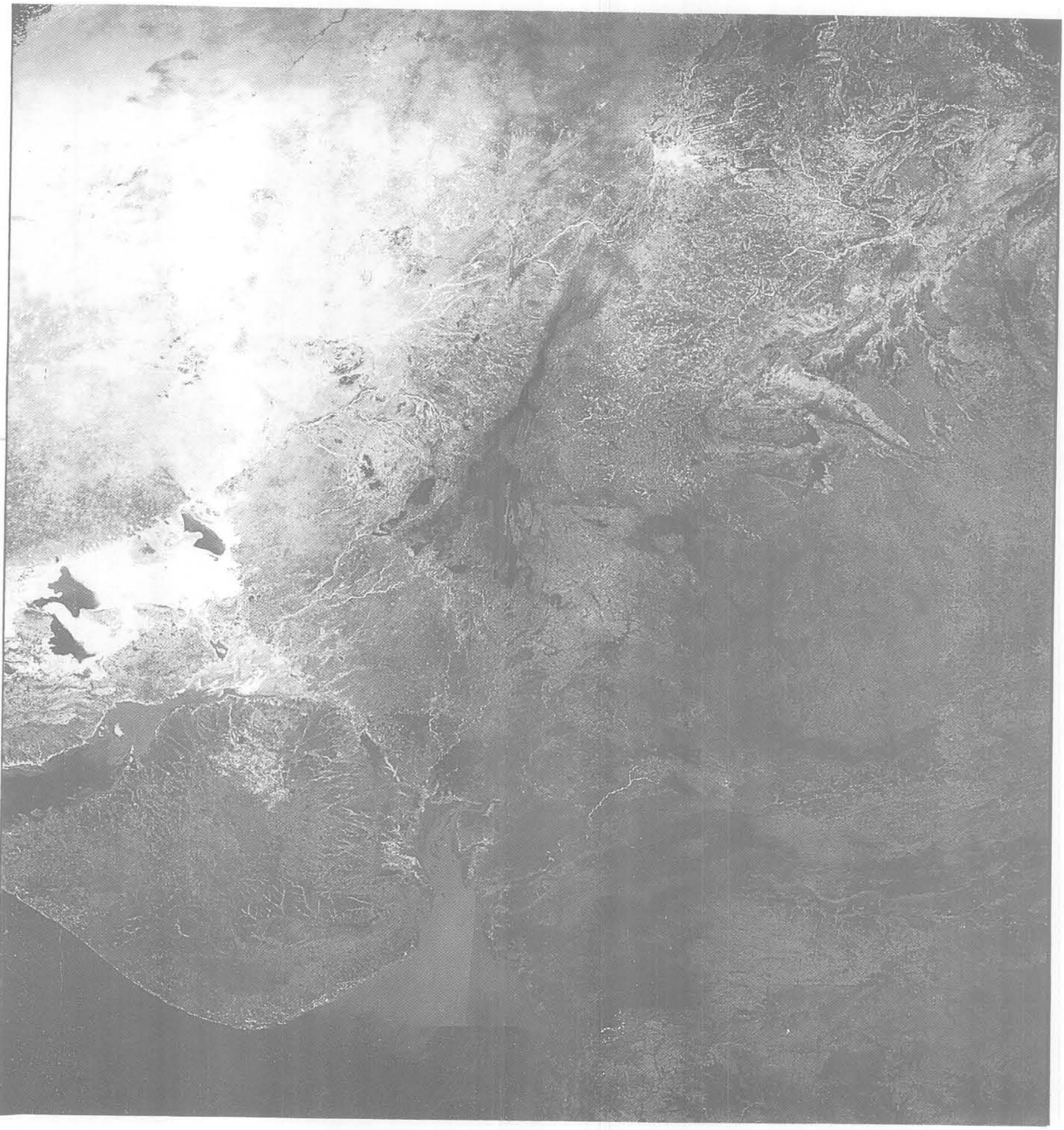
The payload performance parameters are given in Table 2.3.3. Four independently selectable gains are provided for each band/CCD.

SL .NO	PARAMETER	SPECIFICATION
1.	Spatial resolution (m)	188.3
2.	Swath(Km)	810
3.	Spectral band (micron)	B3 0.62-0.68 B4 0.77-0.86
4.	Square Wave Response	B3 >34 B4 >20
5.	Quantisation (bits)	7
6.	Signal to Noise Ratio (at saturation)	>128
7.	Saturation radiance (mw/cm^2-str-micron)	B3 28 ± 1.5 B4 31 ± 1.5
8.	Integration time (ms)	28.4224
9.	Data rate (Mbps)	2.0616

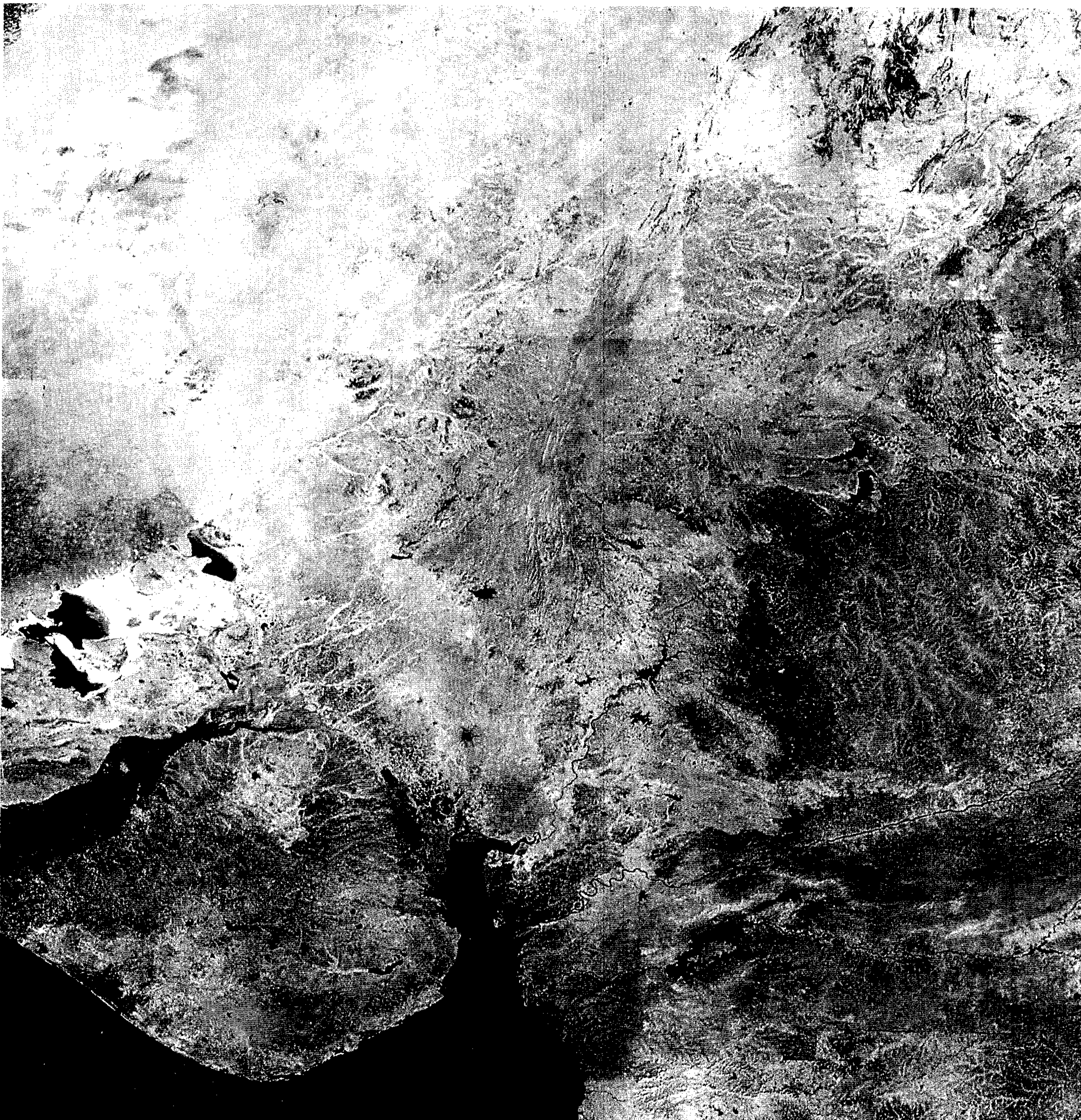
Table 2.3.3 Specifications of WiFS camera



WiFS Camera



Simulated WiFS image (band 3)



Simulated WiFS image (band 4)

2.3.2 PAYLOAD DATA HANDLING SYSTEM

The data handling system basically consists of a base band system and a RF system. The base band system consists of control circuits, oscillators, formatters, randomiser and modulation interfaces. The RF system contains the local oscillators, modulators, power amplifiers and antenna systems.

2.3.2.1 Base band data handling system

The base band data handling system caters to different functions. It formats PAN data and LISS-III data. It provides selection for the half swath data of PAN camera or full swath data of LISS-III for recording.

PAN

The parallel digital data from payload is formatted into two serial PCM streams, viz.,PAN-I and PAN-Q, each with a data rate of 42.4515 Mbps. The PAN camera consists of three CCD arrays. Each CCD array has 4 ports. From each port data is shifted out to base band data handling system. The data from all the four ports of first CCD and port 1 and 2 of second CCD are multiplexed and formatted to stream "I". The data from all four ports of third CCD and port 3 and 4 of second CCD are multiplexed and formatted into the second stream "Q". Each formatted data viz., PAN-I and PAN-Q is merged with low bit rate house keeping data, Gyro fine rate information, channel ID, cal status and line count information. All these data are inserted in appropriate slots.

LISS-III

The LISS formatter accepts digital data from LISS-III payload in three bands and SWIR payload in one band and WiFS data in two bands, and then multiplexes them and formats them into a single PCM stream of 42.4515 Mbps. To this serial stream, auxillary data such as frame sync code, camera ID, house keeping data, Gyro fine rate information and cal status are inserted.

The data from Band-5 (SWIR), which has seven modules of 300 elements, is multiplexed into even and odd channels and output in two ports. The data is shifted similar to Band 2, 3 and 4.

WiFS

WiFS consists of four CCDs each with two ports. The data is shifted in the same way as LISS Bands. The data from WiFS and Band-5 are multiplexed with Band 2, 3 and 4 data. Pre mux are employed for WiFS and Band 5 data.

Onboard tape recorder interface

The data handling system also provides the selected data of either PAN-I (M/R) or PAN-Q (M/R) or LISS-III (M/R) to the onboard tape recorder for recording. The data during playback is received from tape recorder and after splitting the data, it is differentially encoded and fed to QPSK modulator.

2.3.2.2 DATA HANDLING (RF) SYSTEM

The serial data from the base band system is fed to RF system to modulate and transmit the data to ground. The PAN data is QPSK modulated and transmitted by 8150 MHz carrier in X-Band. The LISS-III data is also QPSK modulated and transmitted through 8350 MHz carrier in X-Band. This facilitates transmission of both PAN and LISS-III data simultaneously. Each stream has a power output of 40 Watts. Travelling Wave Tube Amplifiers (TWTA) are employed to achieve this power. Three TWTAs are provided with 2 by 3 redundancy. Two TWTAs are exclusively channelised and meant for PAN and LISS-III while the third one is selectable for either PAN or LISS-III channel.

The playback data from Onboard Tape Recorder is transmitted through LISS-III chain.

A Beacon system with a power output of about + 20 dBM is being provided and it operates at 8255 MHz frequency in X-Band. The Beacon signal is combined with LISS-III signal at the antenna for transmission. The Beacon has capability to switch ON/OFF independently.

Figure 2.3.1 shows the schematic diagram of Data Handling system (RF).

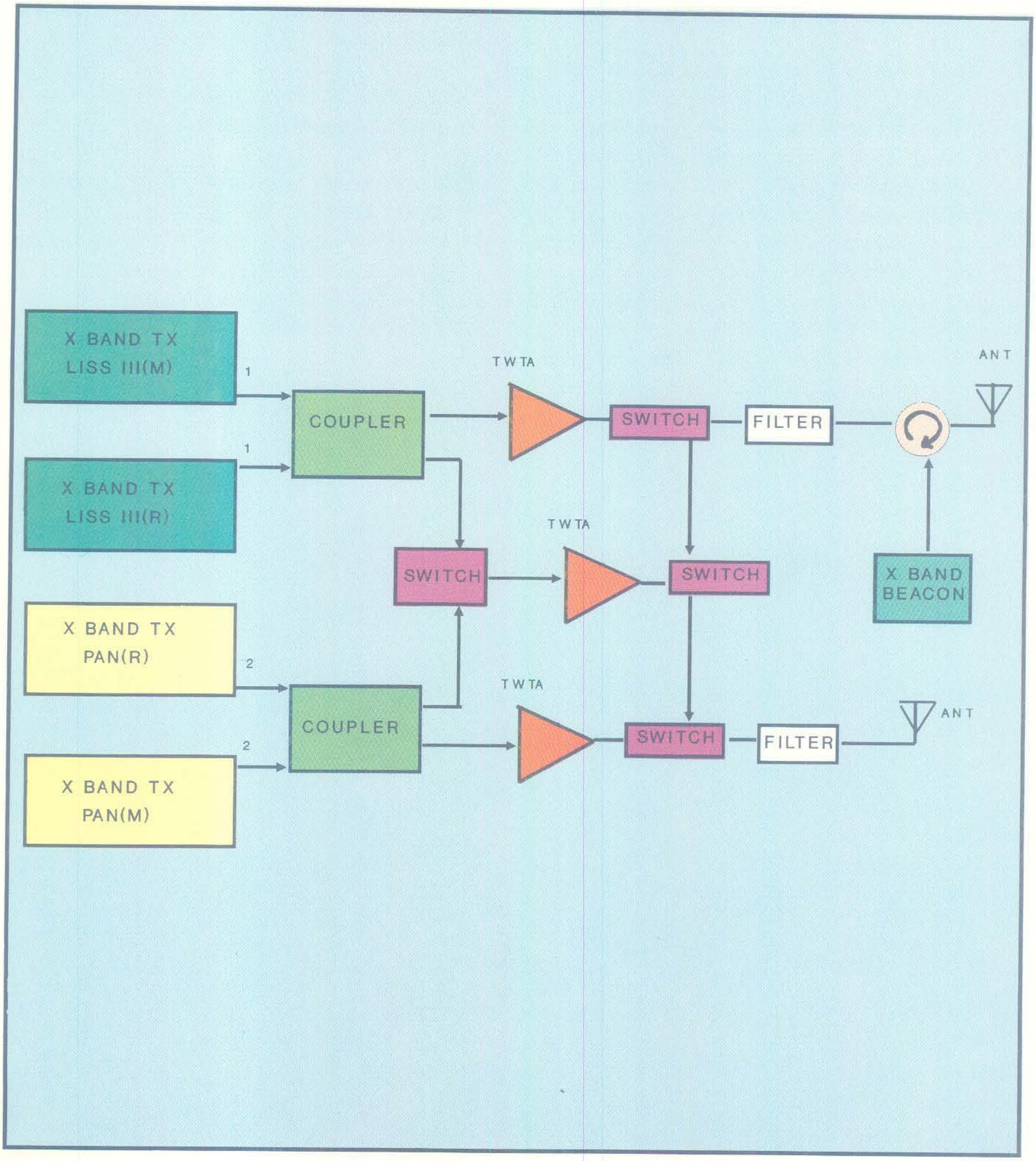


Figure 2.3.1 Schematic diagram of RF data handling system

2.3.3 ONBOARD TAPE RECORDER

It is possible to acquire data outside the visibility region of any ground station through an On Board Tape Recorder (OBTR). The OBTR will be able to record and store data collected for 24 minutes. Data can either be recorded continuously for 24 minutes or in segments. In Segmented mode, data recording will be governed by OBTR decelerating time at the end of recording. Data recorded on the OBTR will be downlinked to the Indian data receiving station during night passes and products will be supplied as per user's requirements. OBTR has capability to receive and record a single stream of 42.4515 Mbps data. Hence, either PAN-I or PAN-Q or LISS-III (with or without WiFS) data can be recorded. The PAN-I or PAN-Q data corresponds to a half swath of 35Km while LISS-III data corresponds to full swath. The reproduced data is configured to be sent through LISS-III chain. Table 2.3.4 gives the major specifications and features of OBTR.

SPECIFICATION	PARAMETER
Data capacity	62 Gb
No. of tracks	14
User data rate	42.4515 Mbps
Tape speed	97.6 IPS
Bit Error Rate	1 in 10^{-7}
Operating modes	Stand by, Reproduce, Record, Rewind, Wind, Power on/off
Start/stop times	maximum 150 s

Table 2.3.4 Major Specifications and features of OBTR

2.4 ORBIT AND COVERAGE

The primary objective is to provide systematic and repetitive acquisition of data of the earth's surface under nearly constant illumination conditions. The satellite operates in a circular, sun-synchronous, near polar orbit with an inclination of 98.69 deg, at an altitude of 817 Km.in the descending node. The satellite takes 101.35 minutes to complete one revolution around the earth and completes about 14 orbits per day. The entire earth is covered by 341 orbits during a 24 day cycle. The orbital parameters are summarised in Table 2.4.1.

The mean equatorial crossing time in the descending node is 10.30 a.m. ± 5 minutes. The orbit adjust system is used to attain the required orbit initially and it is maintained throughout the mission period. The ground trace pattern is controlled within ±5 Km of the reference ground trace pattern.

The sensors collect data with different swaths. The swath of LISS-III sensor in the visible bands is 141 Km while in SWIR band it is 148 Km. The swath of PAN and WiFS sensors are 70Km and 810Km respectively. Details of overlaps and sidelaps between scenes of a sensor are given in Table 2.4.2. The successive orbits are shifted westward by 2820 Km at the equator. Figure 2.4.1 shows a typical Ground trace of the orbits. The entire globe is covered in 341 orbits between 81 deg North and 81 deg South latitudes during the 24 day cycle.

Orbits/cycle	341
Repetivity	24 days
Altitude	817 Km
Semi-major axis	7195.11 Km
Inclination	98.69 deg
Eccentricity	0.001
Period	101.35 minutes
Distance between adjacent traces	117.5 Km
Distance between successive ground tracks	2820 Km
Ground track velocity	6.65 Km/sec

Table 2.4.1 IRS-1C orbit

Payload	Resolution (metres)	Ground swath (Km)	Image size Km x Km	Overlap (Km)	Sidelap at equator (Km)
LISS-III					
Visible	23.5	141	141 X 141	7	23.5
SWIR	70.5	148	141 X 148	7	30
PAN	5.8	70	70 x 70	2	~1 (Opt)
WiFS	188.3	810	810 X 810	~80%	~85%

Table 2.4.2 Overlap and sidelap between the scenes

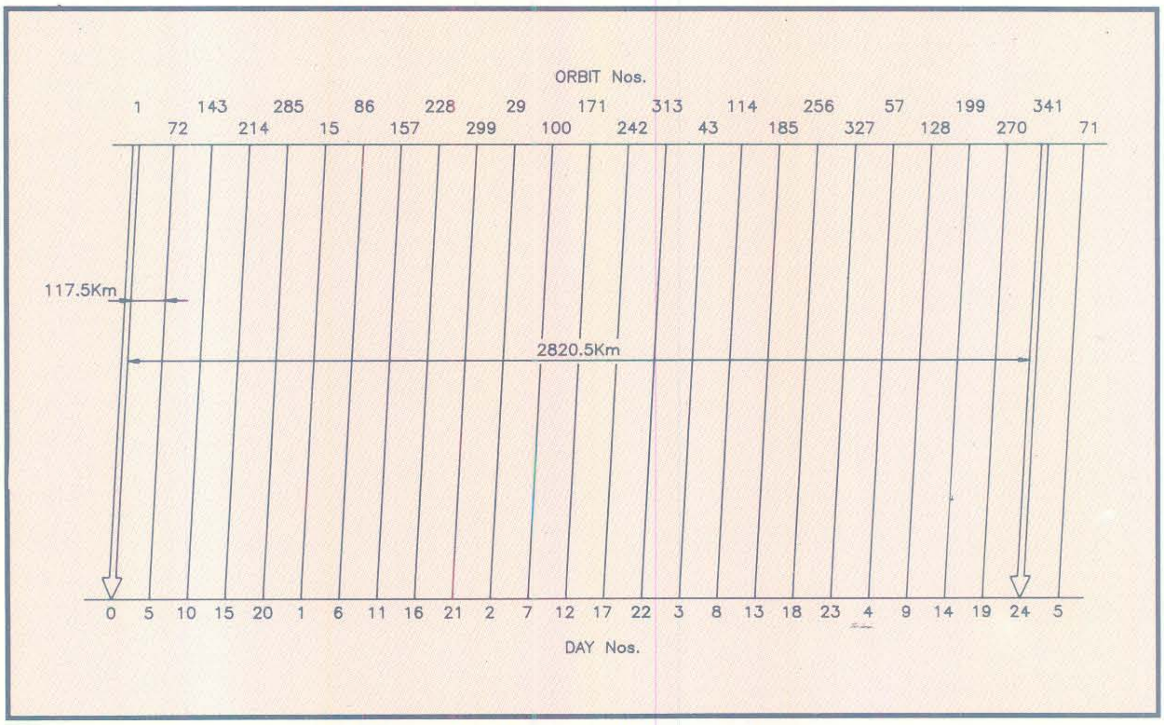


Figure 2.4.1 Ground trace pattern

Scene layout: Figure 2.4.2 shows the scene layout of LISS- III (visible and NIR bands), LISS-III SWIR band and PAN scenes within one WiFS scene. The corners are numbered as shown in the figure. Same pattern of marking the corners is followed for other images also. The LISS-III (SWIR) scenes are framed in such a way that their length is same as LISS-III (V,NIR) scene though its breadth is 7 Km more than a LISS-III(V,NIR) scene.

There is an overlap of 7 Km between adjacent scenes of LISS-III along a path. Also there is a sidelap of 23.5 Km between scenes of adjacent paths at equator. The sidelap is minimum at equator. As we go away from the equator, the sidelap increases because the paths come closer to each other as we move towards the pole. Typically, at 40 deg latitude the sidelap is around 40% of the swath and at 81 deg latitude it is 99%. The Figure depicts the sidelap and overlap in case of LISS-III (SWIR) scenes. It can be seen that the overlap is same as LISS-III (V,NIR) as the lengths of LISS-III (V,NIR) and LISS-III (SWIR) scenes are same. The sidelap is more in the case of LISS-III (SWIR) as the swath is also more when compared to LISS-III (V, NIR).

As the swath of WiFS is very large, there is a sidelap of about 85% between WiFS scenes of adjacent paths at equator. But, between the nth and n+6th path, the sidelap is around 105Km at equator. Also there is a overlap of around 80% between adjacent scenes in a path. But the overlap between mth and m+5th scenes along a path is around 130Km. Hence one out of every consecutive five scenes can be downloaded for data products generation.

Revisit capability of PAN: Because of PAN's tilting capacity, a given area can be viewed more than once within one cycle. This is known as revisit due to PAN's steerability. Figure 2.4.4 shows a path with three adjacent paths on either side from equator, the tilt angle with which the central path can be viewed from adjacent paths and also the day number on which the adjacent paths occur relative to the central path. From the figure it can also be seen that the maximum wait period to view an area is 5 days only. The maximum tilt angle being ± 26 deg, PAN camera can see only three paths on either side at equator. As we go away from equator, paths become closer to each other. Hence, more number of paths can be viewed by PAN at high latitudes.

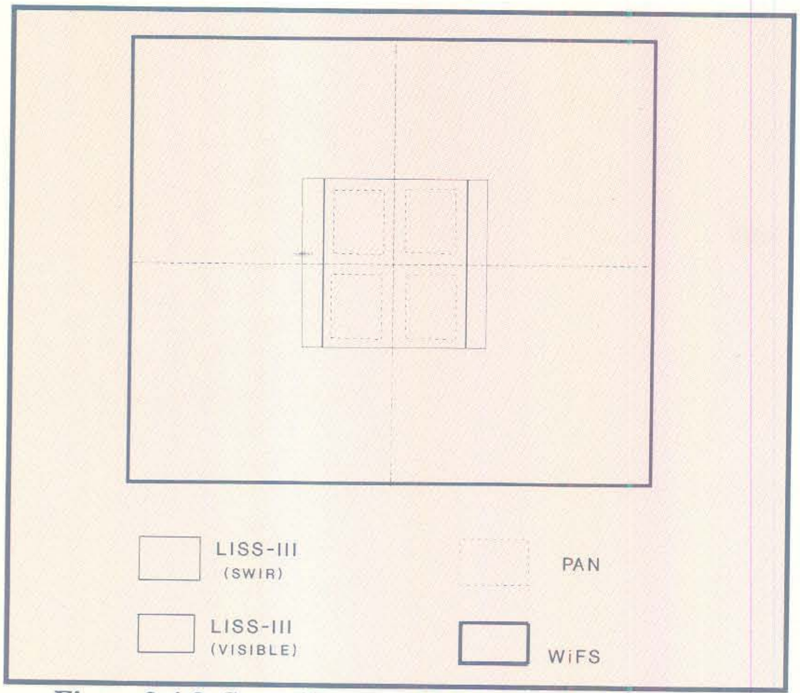


Figure2.4.2 Scene layout of PAN, LISS-III (V,NIR) and LISS-III (SWIR) within WiFS scene

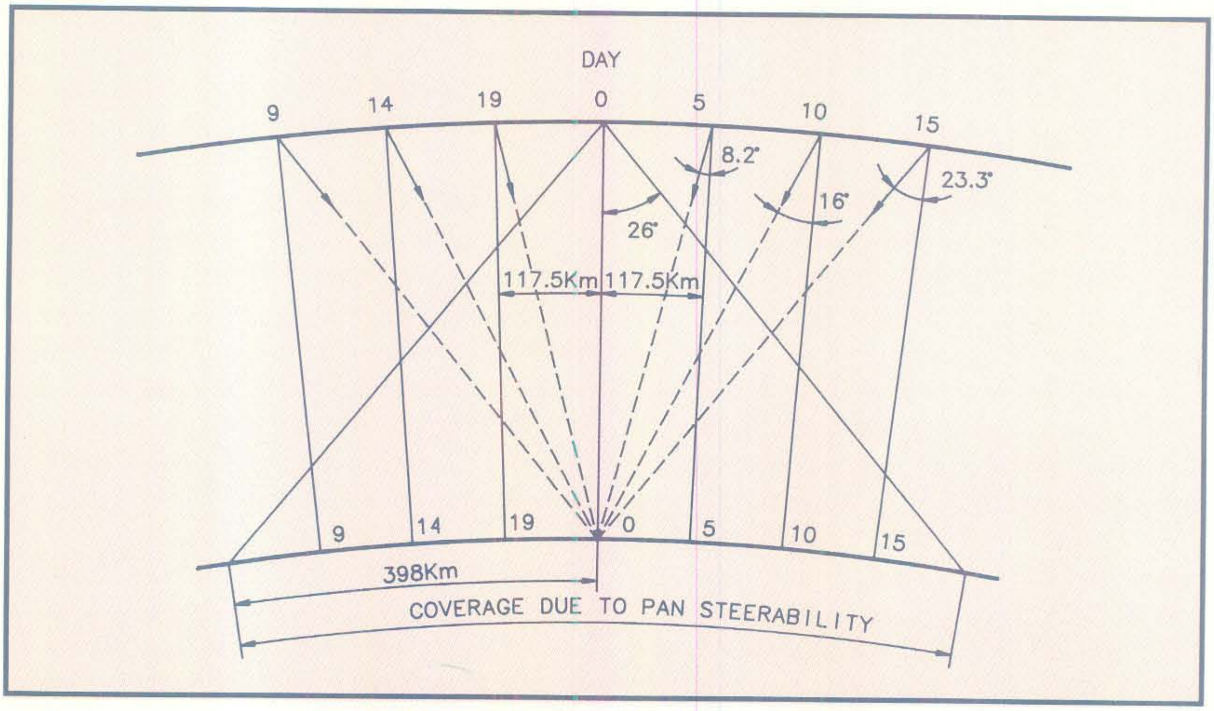


Figure 2.4.3 PAN off-nadir viewing capability

3. GROUND SEGMENT

3.1 GROUND SEGMENT OVERVIEW

The main functions of the Ground Segment are:

- Telemetry Tracking and Command
- Mission Control
- Data Reception
- Data Products Generation and Dissemination

Telemetry Tracking and Command (TTC) functions are carried out by ISRO Telemetry Tracking and Command (ISTRAC) with its Ground Stations located at Bangalore, Lucknow and Mauritius with the selective support from space agencies of Europe, Russia and America. The reception and recording of payload data is done at the erath station of the National Remote Sensing Agency (NRSA), Shadnagar, near Hyderabad. Processing and distribution of all the products are carried out from NRSA, Balanagar, Hyderabad. Mission control support is provided from ISTRAC, Bangalore. Data will also be transmitted to different Foreign Data Receiving Stations (FDRSs). The various elements of the IRS-1C Ground Segment are given in Table 3.1.1 and the Ground Segment Organisation is shown in Figure 3.1.1

ELEMENT	LOCATION	FUNCTIONS
TTC	ISTRAC Ground station at Bangalore, Lucknow and Mauritius	1. Satellite house keeping, data reception and recording 2. Spacecraft commanding and tracking
Mission Control	ISTRAC, Bangalore	1. Network coordination and control 2. Scheduling spacecraft operations 3. Spacecraft HK data logging 4. Orbit, attitude determination and control 5. Communication links between concerned Ground Segment elements
Data Reception	NRSA, Shadnagar	1. Reception and recording of payload data 2. Generation and display of quicklook imagery 3. Generation of ancillary data for product generation
Data Products Generation and dissemination	NRSA, Balanagar	1. Generation and distribution of different types of data products 2. Data quality evaluation, archival and management 3. Payload programming

Table 3.1.1 Ground segment elements and functions

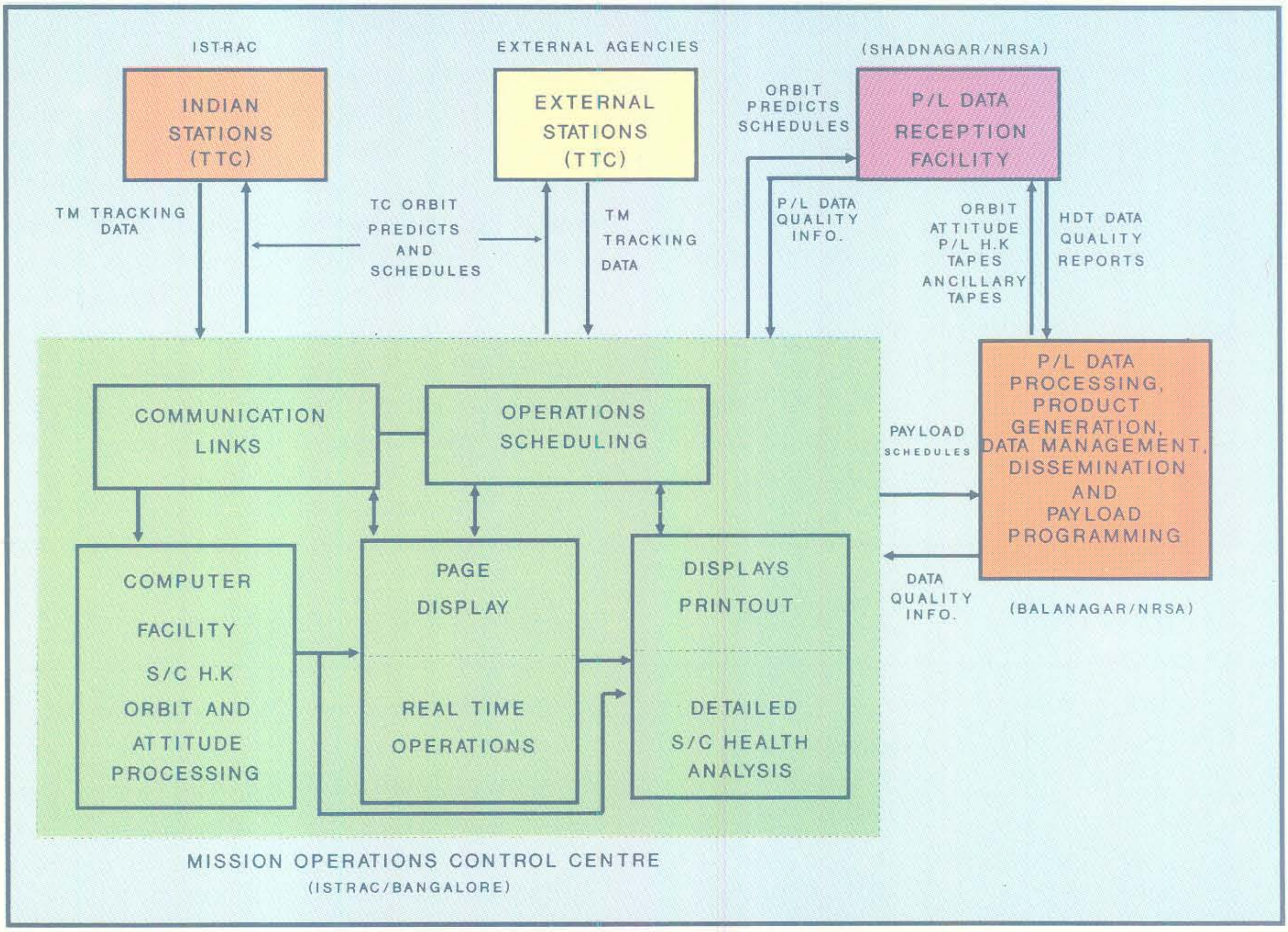


Figure 3.1.1 IRS-1C Ground segment organisation

3.2. TTC AND SPACECRAFT CONTROL CENTRE

3.2.1. INTRODUCTION

The functions related to IRS-1C health monitoring and on-orbit control are performed by a network of Telemetry, Tracking and Command (TTC) stations and a Spacecraft Control Centre (SCC) under the administrative and technical control of ISRO Telemetry, Tracking and Command Network (ISTRAC). Description of various facilities of ISTRAC and their functional responsibilities with specific reference to IRS-1C are provided in the following sections.

3.2.2. SPACECRAFT OPERATIONS AND CONTROL

The TTC network, Spacecraft Control Centre, data links and the operations team, form essential elements of mission control and TTC network. In order to fulfil IRS-1C mission goals and objectives, SCC and the ground station network support a variety of operations on the spacecraft. These include operation of mission payloads viz., PAN, LISS-III and WiFS as per user requests, On-board Tape Recorder (OBTR) record/dump operations and commanding the orientation of PAN camera through onboard steering mechanism. This is in addition to the routine health monitoring and orbital and attitude operations.

3.2.3. IMPORTANCE OF TTC FUNCTIONS

Spacecraft controllers on the ground rely on telemetry to monitor the configuration and health of a satellite. Telecommands provide the means to reconfigure, reorient and reposition the satellite by remote control. Tracking involves, measurement of range and range rate of satellite with reference to a known source, which, in turn determines the position and velocity.

The spacecraft controllers at SCC interact with the TTC stations and co-ordinate in carrying out the commands scheduled during specific segments of an orbit. SCC is equipped with the requisite software tools and display terminals to ensure error-free operations. These operations are carried out on a routine basis to keep the spacecraft in the intended orbit and orientation. Temporary loss of attitude is tackled by the ground controllers, by swift action with the help of contingency operations management procedures.

3.2.4. TTC NETWORK

The term ground network implies a combination of two or more ground stations spread geographically. Spacecraft mission operations and control are contingent upon selection of a suitable network of ground stations to plan and execute appropriate telecommand operations on the spacecraft as per pre-determined time-line. Ground station locations for IRS-1C have been chosen on the basis of mission strategies and sufficient radio visibility requirements of important arcs of the orbit.

The prime network for IRS-1C consists of the TTC stations at Bangalore, Lucknow, Bearslake and Mauritius. Services of certain foreign network stations would be requisitioned for specific durations depending on the exigencies of the mission.

ISTRAC TTC stations are equipped with almost identical systems for Telemetry (TM) reception, tracking and commanding. All stations are provided with transmit-receive antennas of size 10 m with a G/T of 19.5 dB. An acquisition antenna mounted on the main antenna system facilitates initial acquisition of the statellite. Capability to receive up to 3/4 TM carriers with necessary recording, PCM decommutation and quick look facilities exist in all the stations. Each station is provided with a complete telecommand system of 2 KW RF power and high precision range and range rate systems. Each station has almost complete redundancy at all levels. Station computers interact with the mission computers at SCC for data transfer in real time. Figure 3.2.1. gives the block schematic diagram of a typical TTC station. Important characteristics of ISTRAC network stations are given in Table 3.2.1.

1.	Operating frequency	Receive 2200 to 2300 MHz Transmit 2025 to 2120 MHz
2.	Antenna	
	Size	10 m (1 m acq.)
	Gain/Temp	19.5 dB/deg k
	Velocity	9.0 deg/s
	Acceleration	9.0 deg/s^2
	Tracking mode	Auto/Program/CDM/ Manual
	Effective Isotropic Radiative Power	> 70.0 dBw
3.	Modulation	Downlink PCM/PSK/PM Uplink PCM/FSK/FM/PM
4.	Timing Accuracy	100 u s
5.	Transmitter Power	2 kW
6.	Tracking	
	Angles	0.1 deg
	Range	10.0 m
	Range rate	0.1 m/s
7.	Data transfer	X.25 Level-2

Table 3.2.1. TTC station characteristics

3.2.5. FUNCTIONAL REQUIREMENTS OF TTC NETWORK

* To provide dedicated telemetry, tracking and command services for payload operations and spacecraft health keeping throughout the mission life.
* Collect, process and format the tracking data and transmit the same to SCC in real-time.
* Acquire telemetry data and transmit the same in real-time to SCC.
* Generate post-facto orbit and attitude information and transmit the same to NRSA.

The details of various support functions are delineated in the following sub-sections.

3.2.5.1. Telemetry

ISTRAC ground station(s) will receive the down-link signals from IRS-1C spacecraft in real-time and carry out the following activities :

* Demodulate the signal
* Bit and Frame synchronize
* Time tag
* Format into standard blocks for transmission
* Record analog data for recall

3.2.5.2. Telecommand

Telecommand supports remote commanding in real-time during ground station visibility. Provision exists for on-board time-tagging of telecommands. Manual commands entered locally on the encoder also exists. Capability for emergency command operations support at short notice is a special feature of the telecommand.

3.2.5.3. Tracking

Tracking support is provided during any phase of the orbit subject to visibility . The ground stations measure range, range-rate and antenna angles with respect to the spacecraft. This is very essential for spacecraft orbit determination and ephemeris generation.

3.2.5.4. Data Communication

ISTRAC establishes the required communication lines in co-ordination with the national agencies viz., Department of Telecommunications andVidesh Sanchar Nigam Limited (VSNL) and international agencies to ensure transfer of telemetry and tracking

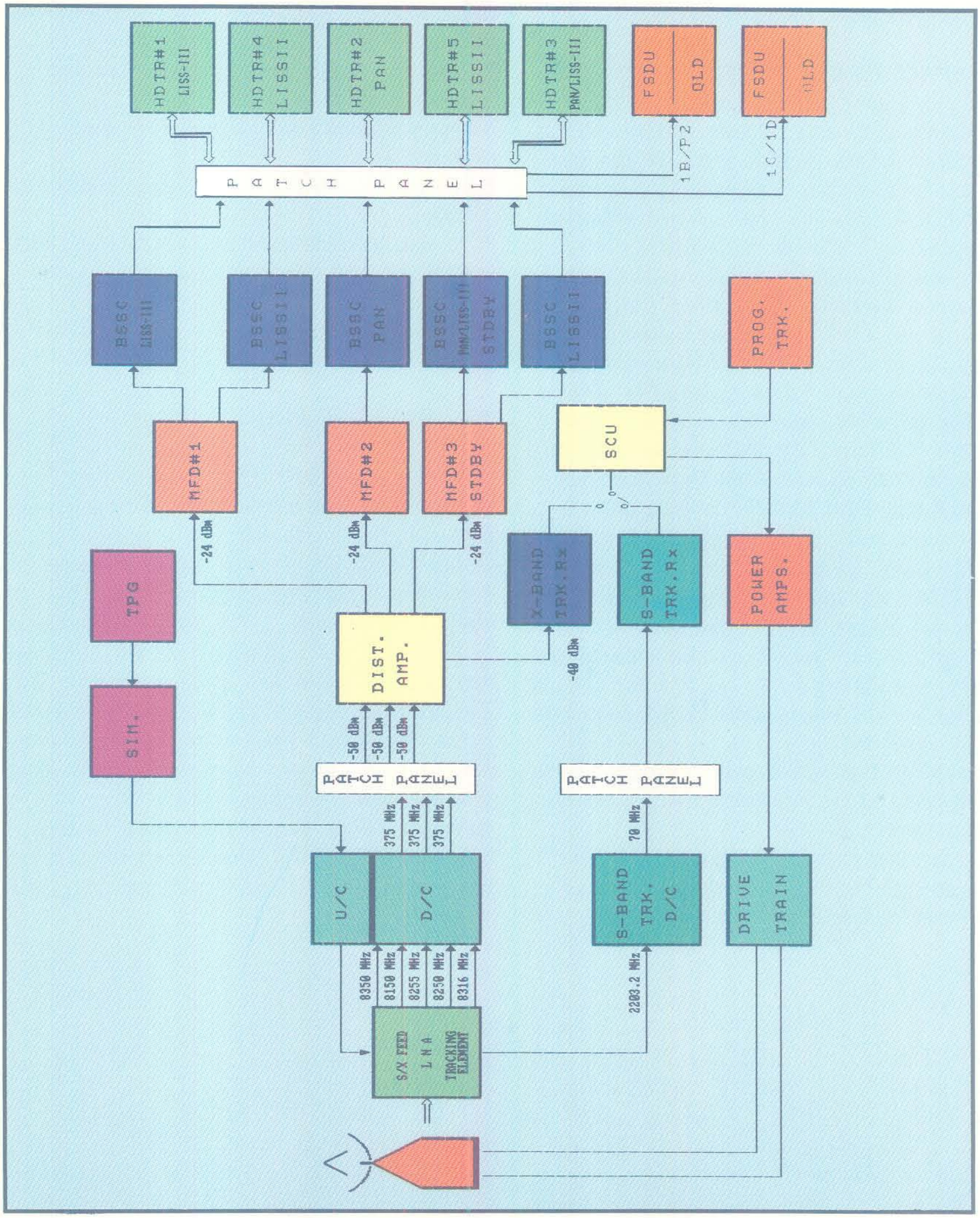


Figure. 3.2.1 Typical ground station configuration

data in real-time using X.25 protocol.

3.2.6. SPACECRAFT CONTROL CENTRE

The Spacecraft Control Centre (SCC) located at Bangalore is the nerve-centre of all TTC and spacecraft control operations. SCC comprises of several observation consoles and control terminals connected to a cluster of real-time mission computers in ethernet configuration. These computers interact with remote stations for telemetry and tracking data acquisition through dedicated data links. Functional block diagram of SCC elements and the interfaces with TTC stations, Data Reception Station and spacecraft design teams is shown in Figure 3.2.2. All mission operations activities are carried out from the Dedicated Mission Control Room (DMCR) in the normal phase. SCC is configured to handle many spacecraft missions simultaneously. It is equipped with required number of computer systems with attendent software for on-line and off-line support, data communication equipment, display consoles, graphic terminals and plotters to facilitate smooth and flawless mission operations. The major tasks of the Spacecraft Control Centre are :

* Scheduling of spacecraft operations and execution of orbit and attitude manoeuvres as per mission requirements
* Orbit and attitude determination
* Scheduling of command operations as part of payload programming
* Routine house-keeping data processing and health monitoring in real-time.
* Spacecraft health data archival and database management
* Spacecraft health analysis and performance evaluation
* Sub-system performance monitoring through trend analysis
* Co-ordination with various network stations, DRS, NDC and other related agencies to realize the above tasks
* Fault detection, isolation and recovery in case of spacecraft emergencies

3.2.7. PAYLOAD PROGRAMMING

Payload programming is an operation scheduling process which involves translation of the prioritised payload operational requirements from NRSA Data Centre (NDC) into a set of sequential command operations. These commands are merged into the multi-satellite general operations schedule of ISTRAC. ISTRAC will plan spacecraft command operations to enable data access by Foreign Data Reception Stations (FDRS) scattered all over the world. Assuming atleast one payload operation per pass, the total commanding requirements are likely to be more than 100 command operations per day on the payloads alone. This involves close co-ordination between NDC and SCC. Further details on this can be found in section 5.9 of this manual.

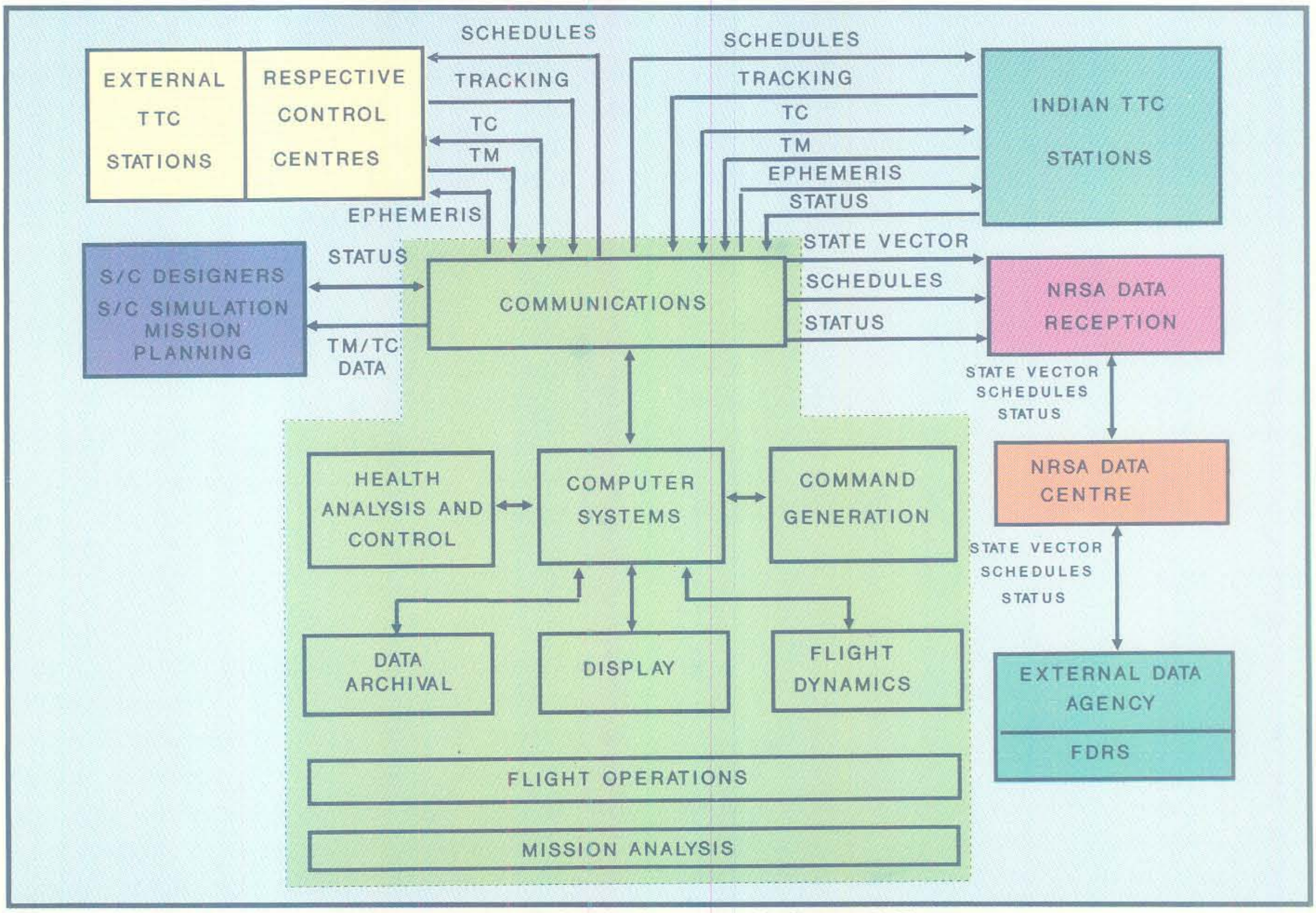


Figure. 3.2.2 IRS-1C Spacecraft Control Centre

Spacecraft Control Centre, ISTRAC

3.3 DATA RECEPTION STATION

3.3.1 INTRODUCTION

The Data Reception Station at Shadnagar will receive payload data (PAN, LISS-III and WiFS) Beacon in X-Band and house keeping and telemetry data in S-Band.

The earth station has the capability to track and receive data from any satellite operating in frequency bands 2200-2300 MHz and 8025-8400 MHz (allocated for Remote Sensing)

3.3.2 EARTH STATION CONFIGURATION

The Ground Station at Shadnagar near Hyderabad consists of:
- Data Acquisition System
- Data Archival and Real Time System
- Communication Links

The existing Servo Control Systems will be replaced with microprocessor based servo controller, which, in conjunction with the above system will provide reception capability for IRS Mission in X and S Band. A set of two High Density Tape Recorders (HDTR) provide the raw data archiving capability for the payload (PAN and LISS-III) as well as telemetry data with one to one back up capability. The third HDTR is available as back-up for recording either LISS-III or PAN data. A VAX 3400 based computer system provides capability for Quick Look and Real Time System Telemetry Data reproduction and processing of the same to generate level '0 'products.

3.3.3 DATA ACQUISITION SYSTEM

Data Acquisition System at Earth Station Complex in Shadnagar receives and records video data of PAN, LISS-III and WiFS cameras on High Density Digital Tape (HDT). Simultaneously, both camera data are displayed on Quick Look displays. The Data Acquisition System comprises of four constituent elements:
- Antenna System
- Servo Control System
- Receive/Tracking System
- Recording System

Essentially, the system provides for :
- Acquisition and recording of payload and telemetry data
- Tracking of satellite in both X and S Bands
- Back-up operations through Landsat/ERS terminal.

3.3.3.1 Antenna system

This consists of a 10 metre diameter antenna on a compact tracking pedestal. The components of the antenna are of segmental configuration and low weight,bolted construction enabling quick dismantling and assembly without elaborate alignment process. The reflector consists of a machined reinforced circular hub which supports twenty four radial truss-ribs, twenty four panels and other circumferential bracings. All the interconnecting parts of the reflector are machined, so that no optical alignment techniques are required at the time of assembly. Antenna system characteristics are given in Table 3.3.1.

Main reflector	:	10 metre diameter
Subreflector	:	1.5 metre diameter
Focal length over diameter ratio (F/D)	:	0.39
Surface accuracy	:	0.8 mm RMS static 1.25 mm RMS at 96 Kmph wind
Weight	:	1.6 tonnes
Survival wind velocity	:	200 Kmph

Table 3.3.1 Antenna system characteristics

3.3.3.2 Tracking Pedestal

The compact tracking pedestal is a steel structure housing drive trains, synchro and limit switch packages and interlocks for both azimuth and elevation axes. Tracking pedestal characteristics are given in Table 3.3.2.

Type	:	Elevation over Azimuth mount
Input power required	:	415/240 V, 50 Hz, 4 wire 3 phase
Delivered torque at each axis	:	81345 Newton meter
Orthogonality tolerance	:	0.02 deg
Gear type	:	Precision spur gear
Gear ratio	:	AZ 1026:1 EL 1700:1
EL travel limits	:	Primary (Electrical) -2 deg., ±182 deg. Secondary (Mech) -5 deg., ±185 deg.
AZ travel limits	:	±360 deg
Stowing	:	Hand crank
Weight	:	5.5 tonnes

Table 3.3.2 Tracking pedestal characteristics

Antenna

3.3.3.3 Servo Control System

The system can be broadly classified into three parts based on digital elements (for mode selection, backup and switching signal routes), analog signal (processing forming position and rate compensation, feed-back networks) and power electronics (employing fully reversible Silicon Controlled Rectifier (SCR) bridge controlling DC motors drawing the antenna). Servo Control system consists of microprocessor based Servo Controller, a PC, Power amplifiers and other interfaces with cables to work as a torque biased dual drive closed loop control system. Servo control system specifications are given in Table 3.3.3.

Operating modes	:	Ready, Manual rate, Manual position, Com mand angle program track, Auto track, Position memory, Rate memory, Auto track and Auto acqui sition.
Motors	:	Permanent magnet, shunt wound DC motor, 7.5 HP, two per axis, short time rating upto 15 HP, rated speed 5000 RPM.
Drive type	:	Dual motor drive for each axis with torque bias arrangement to eliminate back-lash.
Max velocity	:	AZ 22 deg/s EL 10deg/s
Max acceleration	:	AZ 5 deg/sec^2. EL 1 deg/sec^2
Bandwidth	:	NB II-0.5 Hz WB II-0.85 Hz
Overshoot	:	30 percent maximum
Locked rotor freq	:	4.2 Hz
Dynamic RMS accuracy per axis	:	±0.08 deg

Table 3.3.3 Servo control system specification

3.3.3.4 Receiving System

The PAN data at 8150 MHz and LISS-III data at 8350 MHz and beacon in X-Band(8255 MHz) are received by composite X and S-Band feed for single channel monopulse configuration in cassegranian arrangement and amplified in preamplifiers. The X-Band signals are down converted to an IF of 375 MHz and the S-Band signals are down converted to an IF of 70 MHz. The X Band Down-converter is having 3 channels for Down Conversion and two channels for Up-Coversion. Up-Conversion mode is used for RF loop checks. These UP/DN convertors can be used for any frequency in X-Band. The down converted signals are QPSK demodulated. The final extracted data and clocks from Demod/ BSSC are recorded on HDTRs. The telemetry data received for house-keeping includes PM Demodulator, sub-carrier PSK demodulators and bit synchronizers. Receiving system specifications are given in Table 3.3.4.

	X-BAND	S-BAND
Polarisation	RHC	RHC
Axial Ratio (dB)	2	1.5
Sum Channel Gain at preamp input (dBi)	54.0	43
Frequency Band (MHz)	8025-8400	2200-2300
IF Frequency (MHz)	375	70
System G/T (dB/degK)	31.0	19.5
Bit rates	PAN 84.903 Mbps LISS-III 42.4515 Mbps	Telemetry 512 bps

Table 3.3.4 Receiving system specifications

3.3.4. DATA ARCHIVAL AND LEVEL-0 SYSTEM

The functions of Data Archival and Level-0 System at Shadnagar are as follows.

* Reception and recording of Payload and OBTR data (daily) and CAL data (on scheduled days).
* Quick look display for LISS-III, PAN and WiFS for payload as well as OBTR.
* Real time Telemetry support to SCC.
* Generation of ancillary data for product generation of LISS-III and PAN.
* Generation of ancillary data and raw data on optical disks for WiFS
* Generation of condensed calibration data for data quality evaluation
* Act as router for messages between SCC and NDC for payload programming

3.3.4.1 Data Archival System

<u>Payload</u>

The data from LISS-III and PAN at 42.45 and 84.903 Mbps respectively are recorded on two different HDTRs along with IRIG-A time code. Recording densities are kept at 33.33 Kbps. In the case of LISS-III, data of two passes will be recorded on one tape while for PAN, data of only one pass will be recorded on each tape. These recorders have the facility to read after write for verifying the data recording in real-time. Data archival system is shown in Figure 3.3.1.

<u>On Board Tape Recorder (OBTR)</u>

PAN-I / PAN-Q / LISS-III data from OBTR will be recorded on one HDTR at 42.45 Mbps. Data from two passes will be recorded on one tape. This data is played back in reverse mode for further processing.

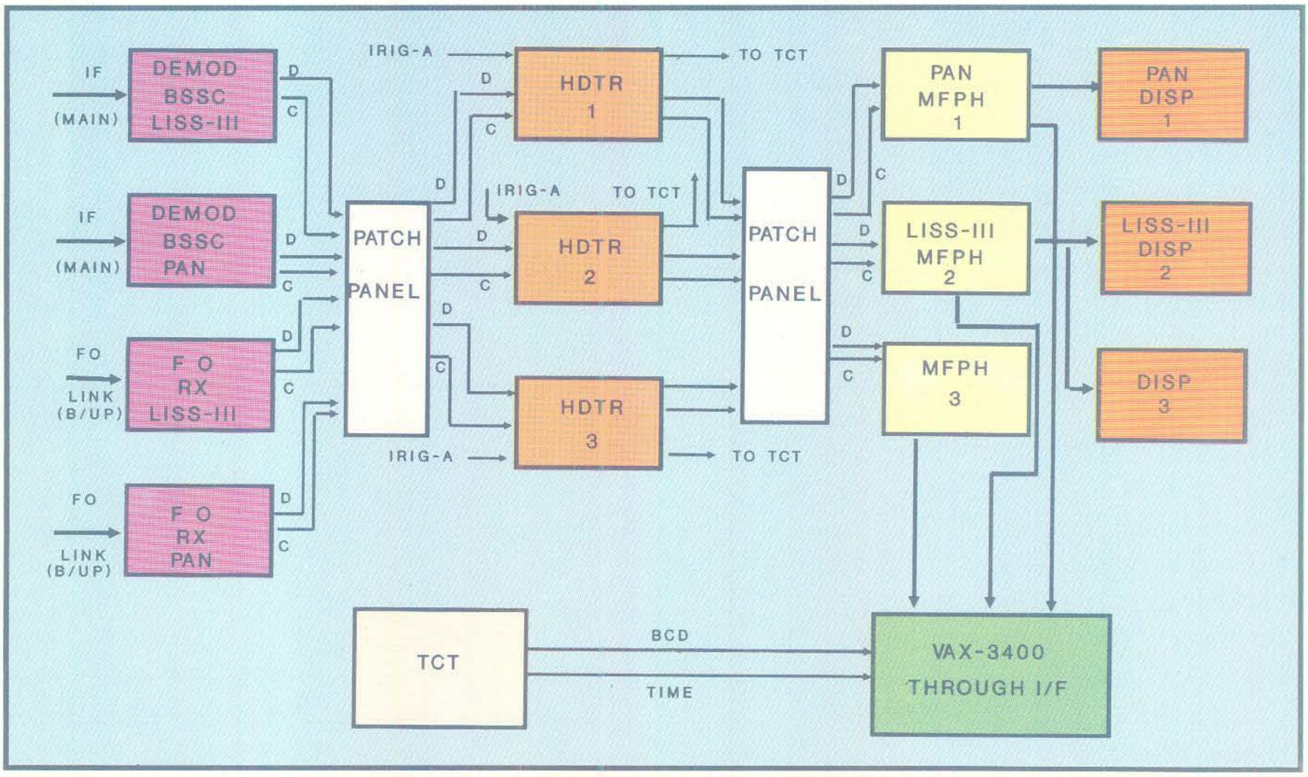


Figure 3.3.1 Block diagram of data archival system

Data archival system

Calibration

CAL data for LISS-III and PAN will be recorded on single HDTR on different scheduled days. LISS-III Cal data will be recorded at 42.45 Mbps and PAN cal will be recorded at 84.903 Mbps. Table 3.3.5 gives the specifications of HDTR.

Description	: LISS-III and OBTR PAN
Model	: HD-96e
No. of Tracks	: 28
No. of HDT Tracks for Payload	: 24
No. of Direct Tracks	: 2
Recording Speed (IPS)	: 63.5127
Packing Density (Kbps)	: 33.33
Bit Error Rate (BER)	: $1X10^{-8}$
Input Data and Clock Level	: ECL (SE)
Output Data and Clock Level	: ECL (SE)

Table 3.3.5 Specifications of HDTR

3.3.4.2. Timing Systems

The time accuracy at Level-0 System affects the along track location accuracy. Hence the time is maintained precisely with respect to Universal Time (UT). This is achieved by means of Time Code Generator (TCG) which is driven by a highly stable oscillator. The TCG which provides the required IRIG-A time code, is synchronized with respect to a Global Positioning System (GPS) receiver. This way the time accuracy achieved is better than 5 Micro Seconds. The timing system is shown in Figure 3.3.2 and specifications are given in Table 3.3.6.

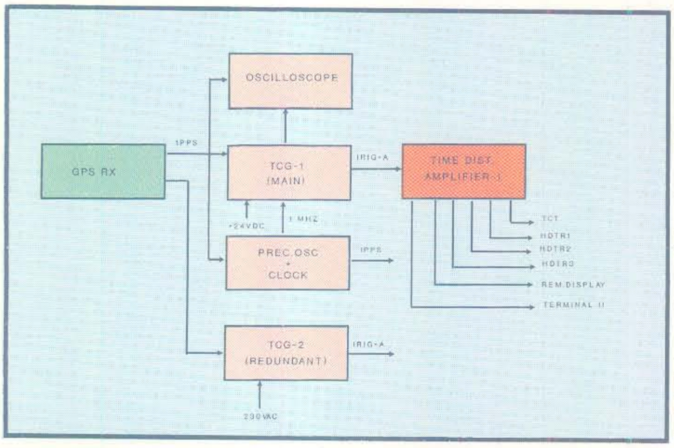


Figure 3.3.2 Block diagram of timing system

GPS Receiver Model	:	DATUM/9390-5500
Time Accuracy	:	1 micro second
Location Accuracy	:	about 150 mts
GPS Code	:	Coarse Acquisition Code (C/A)
Time Code Generator/ Translator (TCG/TCT)		
Model	:	Odetics
Output Time Code	:	IRIG-A/ IRIG -B (selectable)
Control	:	16-bit Parallel Interface.
Output	:	48-bit Parallel BCD
Precision Oscillator		
Model	:	Oscilloquartz
Power	:	230V AC/24V DC ±10% with Battery backup for 2 Hrs.
Stability	:	Better than 1x10e-11
Output	:	1, 5 , 10 MHZ Sine wave signal

Table 3.3.6 Specifications of timing system

3.3.5 LEVEL 0 SYSTEM

The Level 0 system provides the basic information like orbit, attitude, payload data quality and Payload House Keeping required for generation of higher level products. In addition to this, the system generates pass supporting information like

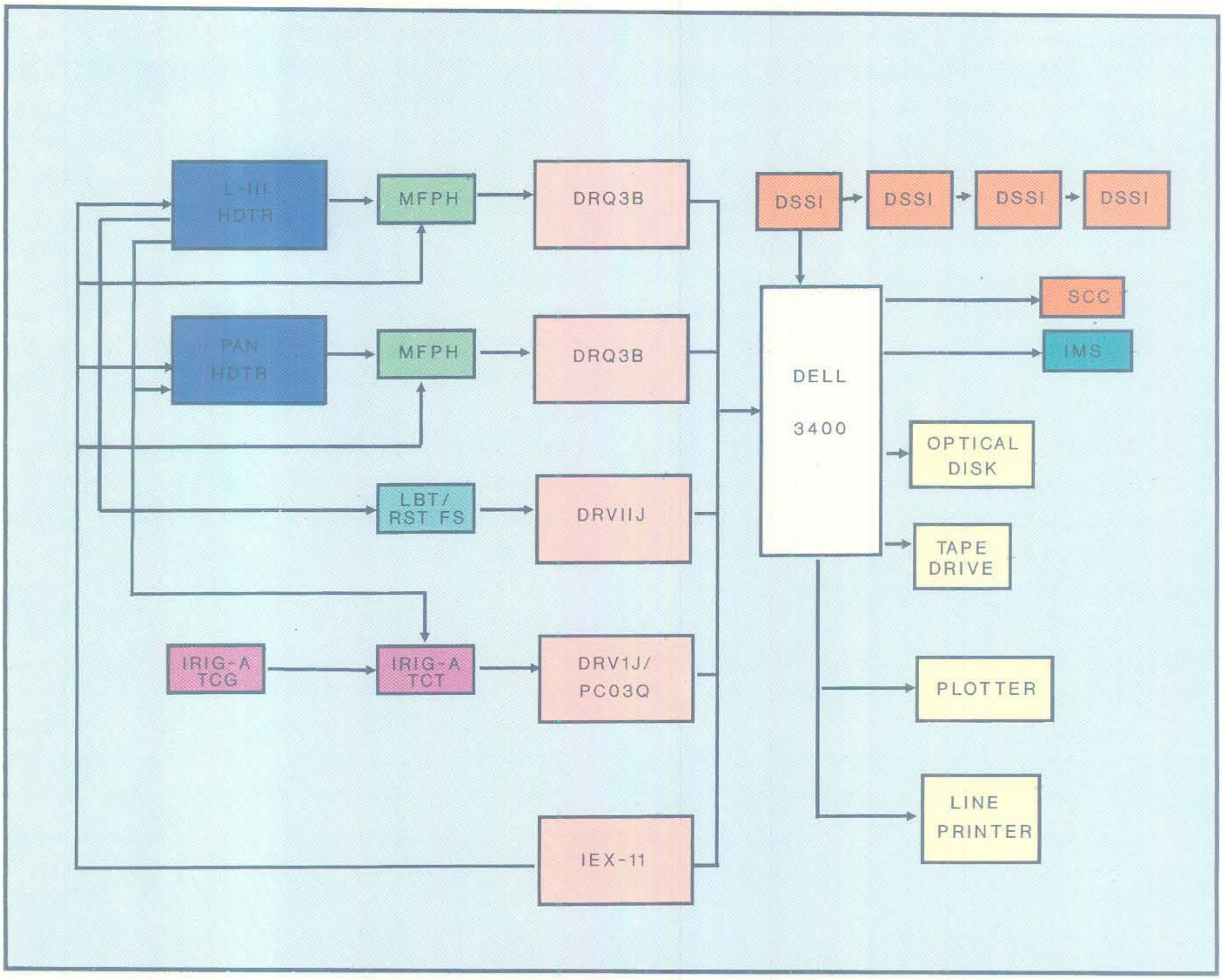


Figure 3.3.3 Block diagram of Level-0 system

AOS/LOS, antenna pointing angles required for tracking and scene framing information for real time display of payload data. This system processes and displays spacecraft subsystem health parameters in terms of pages on alphanumeric terminal for normal, OBTR and calibration modes of operations. The level-0 system is shown in Figure 3.3.3. The level-0 computer system is configured around VAX-3400. During data acquisition, the ancillary data from payload is extracted by Multifunction Front-end Processing Hardware (MFPH) and logged onto level-0 computer disk. Similarly, Low bit telemetry (LBT) and Star sensor data are also logged into the system through telemetry interface unit. The ancillary /LBT / Star sensor data is used to determine attitude, extract payload health related parameters and payload data quality information.

The state vector information coming from spacecraft control centre, Bangalore, is used to generate ephemeris and scene framing information. The ancillary data information file contains orbit, attitude, payload health and payload data quality in the specified format. This information will be transferred to Integrated Information Management System (IIMS) at Balanagar, Hyderabad, either on the Network or on magnetic tape called Ancillary Computer Compatible Tape (ACCT). In addition to this, the system generates WiFS ancillary and video data information on an optical disk in the specified format for processing at Data Processing System (DPS), Balanagar. In the case of OBTR, data will be recorded on one HDTR. Quick look display for OBTR data can be seen without annotation by playing back the recorder in reverse mode. Ancillary information will be generated separately for OBTR data. During scheduled calibration passes, Calibration Computer Compatible Tape (CALCCT) is generated. This CALCCT will contain the results of the analysis of one cycle of selected sensor's calibration data.

Multi-Function Front-end Processing Hardware Unit (MFPH)

MFPH will receive data either from HDTR or built-in simulator. MFPH is intended for front-end preprocessing of data from IRS. It will receive data and clock, conditions them, Frame synchronize and de-randomize before word synchronization. It will format and buffer the data suitably for display and transfer to the computer. It is connected to VAX-3400 using a DMA interface.

Telemetry Interface Unit (TIU)

This is a programmable frame synchronizer and processing unit. This is used for processing the Low Bit rate Telemetry (LBT - 512 bps) and Raw Star Sensor (RST- 6.4K bps) data received from the satellite or from an in-built simulator. The processed data is fed to the computer system through DMA interface.

3.3.6. NETWORKING INTERFACES

The Level-0 Computer System of IRS-1C is connected to SCC Systems and IMS systems on Network for the Transfer of various messages like State Vectors, Attitude Bias, Raw Star Sensor

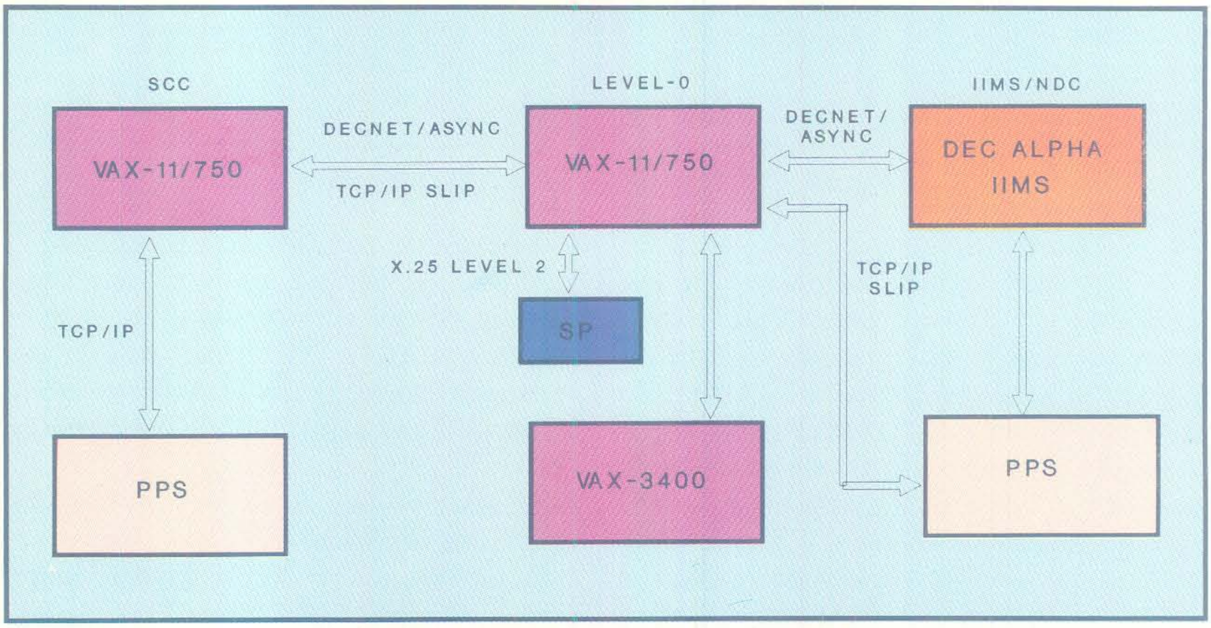


Figure 3.3.4 Block diagram of SCC-Shadnagar-Balanagar Networking interfaces

Data, Schedules, Payload Programming requests and confirmations and ACCT Transfer. These systems on the network will be operated under heterogeneous Networking environment like DECnet and TCP/IP on the available communication links. The networking interfaces are shown in Figure 3.3.4

Communication Links

NRSA is connected to SCC through voice, data and TP links. DRS and DPS are also connected similarly. NRSA communication links are shown in Figure 3.3.5

3.3.7 SCC INTERFACE HARDWARE UNIT

In order to enable data transfer related to station status and also the HK telemetry data collected in real time, a hardware interface unit has been envisaged which is designed and developed by ISTRAC. The status of various equipment at the data reception station will be made available on a panel by NRSA which will be accessed by the ISTRAC hardware unit. The HK telemetry data from the frame synchronizer and the time information from the time distribution unit will also be fed to the interface unit. All the data will be formatted and multiplexed by the unit before transmitting to SCC on lines. Regular ACCT data transfer will be done through data link from DRS Shadnagar to DPS Balanagar. The data transmission will be in the form of blocks and the protocol adopted is X.25 level 2.

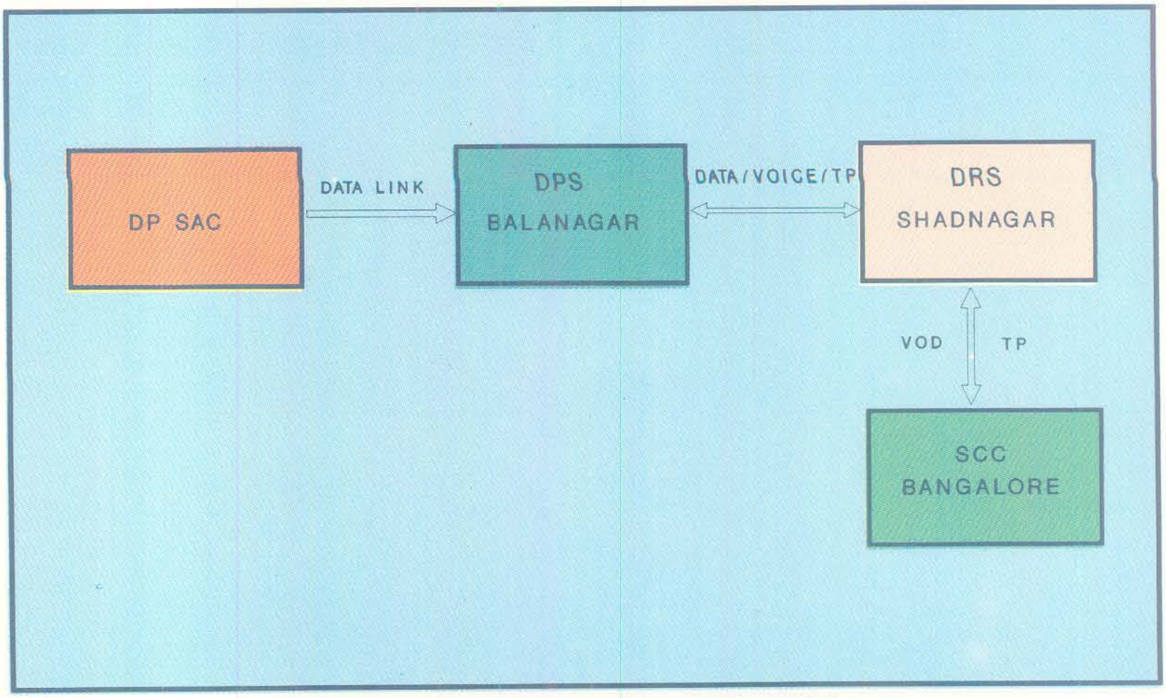


Figure 3.3.5 NRSA Communication Links

3.4 DATA PRODUCTS GENERATION FACILITY

3.4.1 INTRODUCTION

The IRS Data Products Generation Facility is designed to establish facilities for operational generation of photographic and digital products of IRS data after various levels of processing for supply to users in response to their requirements. A catalogue of all acquired data is generated routinely according to an IRS image referencing scheme. A catalogue of master photographic and digital products is also maintained and updated.

The major functions of IRS Data Products Generation Facility are:

* Reception and recording of Payload and OBTR data.
* Generation of ancillary data
* Data processing and data products generation system.
* Photographic products generation system.
* Archival system for all payload data from IRS along with corresponding ancillary data and master copies for all generated products.
* An Integrated Information Management System for efficient management of products generation and dissemination activities and project management related activities.
* User interface to answer user queries and to distribute data products in response to user requests.
* Evaluation of the quality of data for monitoring / corrective actions.

The flow diagram for data product generation is given in Figure 3.4.1.

Recording and generation of ancillary data are carried out at Shadnagar ground station and this has been already discussed in detail in Section 3.3

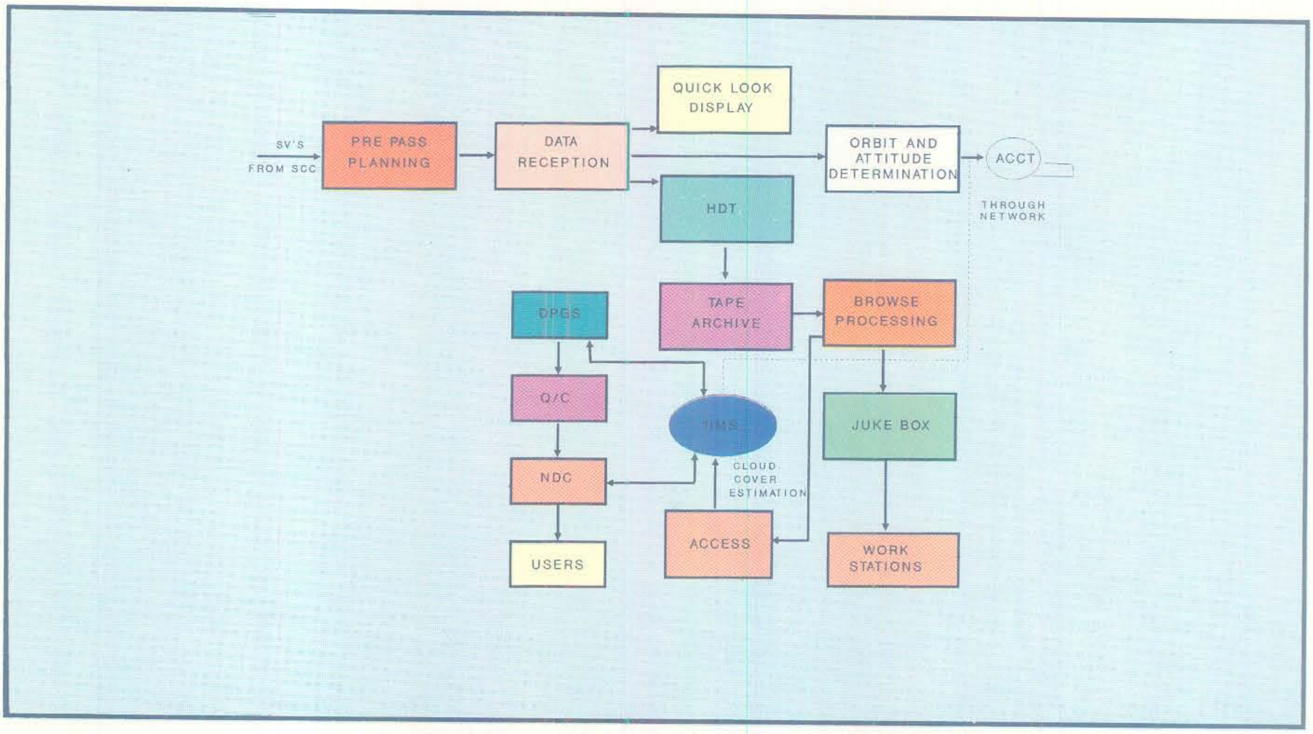


Figure 3.4.1 Flow of data products generation facility

3.4.2. BROWSE PROCESSING AND BROWSING SYSTEM (BPS)

The main functions of Browse Processing and Browsing System are:

* Generation of radiometrically and geometrically corrected (for earth rotation only), annotated, and subsampled (to 1K x 1K scene size) browse images of PAN, MIR and LISS-III (three bands colour) data over land area in normal and OBTR modes.

* Transfer the uncompressed LISS-III browse scenes and MIR raw data to a PC-based system called `ACCEPT' where cloud cover is estimated for these scenes in automatic mode.

* Transferring the browse processed and compressed images onto an Optical Juke Box for archival and later for retreival by NDC/Users.

* Updation of IMS database with browse scenes availability information.

* Browsing and displaying the user requested scenes on a 1K x 1K monitor with different options (like single, same scene of different cycles, all scenes of a path or a range of scenes of paths selected) for knowing the cloud cover and data quality of the same.

Normally browse processing of all the scenes (mentioned above) will be completed on BPS within 24 hours of data acquisition at the Shadnagar Earth Station.

Configuration of the BPS is given in Figure 3.4.2.

3.4.3 DATA PROCESSING SYSTEMS (DPS)

DPS systems are responsible for converting the raw video data into different specified products after

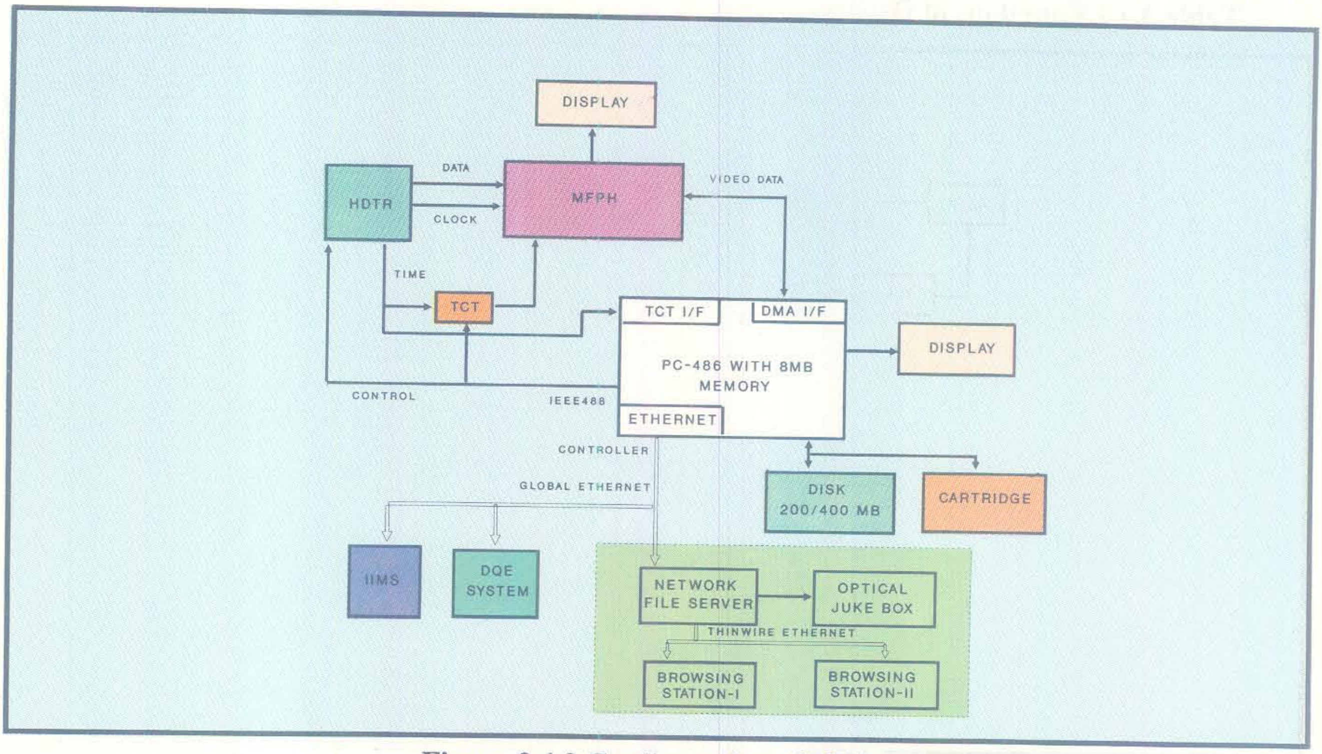


Figure 3.4.2 Configuration of BPS

necessary processing. For IRS-1C operations, the three processing systems identified are:

i. Data Processing System - 1 (DPS - 1)
ii. Data Processing System - 2 (DPS - 2)
iii. Data Processing System - 3 (DPS - 3)

The functional goals for the three DPS systems are given in Table 3.4.1.

System	Functions
DPS-1	Generation of standard and special products of LISS-III and PAN
DPS-2	Generation of standard and special products of LISS-III and PAN
DPS-3	Generation of WiFS data products, support for Swath Modelling, DQE and Ground Control Point library updation

Table 3.4.1.Functions of DPS systems

3.4.3.1 Data Processing System - 1

The main functions of this system are :

* Distribution of work orders to DPS-1, 2 or 3 for product generation through the master scheduler based on production load and capacity of each DPS

* Generation of Standard, Geocoded,Special and Stereo data products

* Diskload operations for Swath Modelling or backdated WiFS product requests

* Floppy products generation on the PC which is connected to DPS-1

* Intermediate DAT products generation for Cartridge products.

Configuration of DPS-1 is given in Figure 3.4.3.

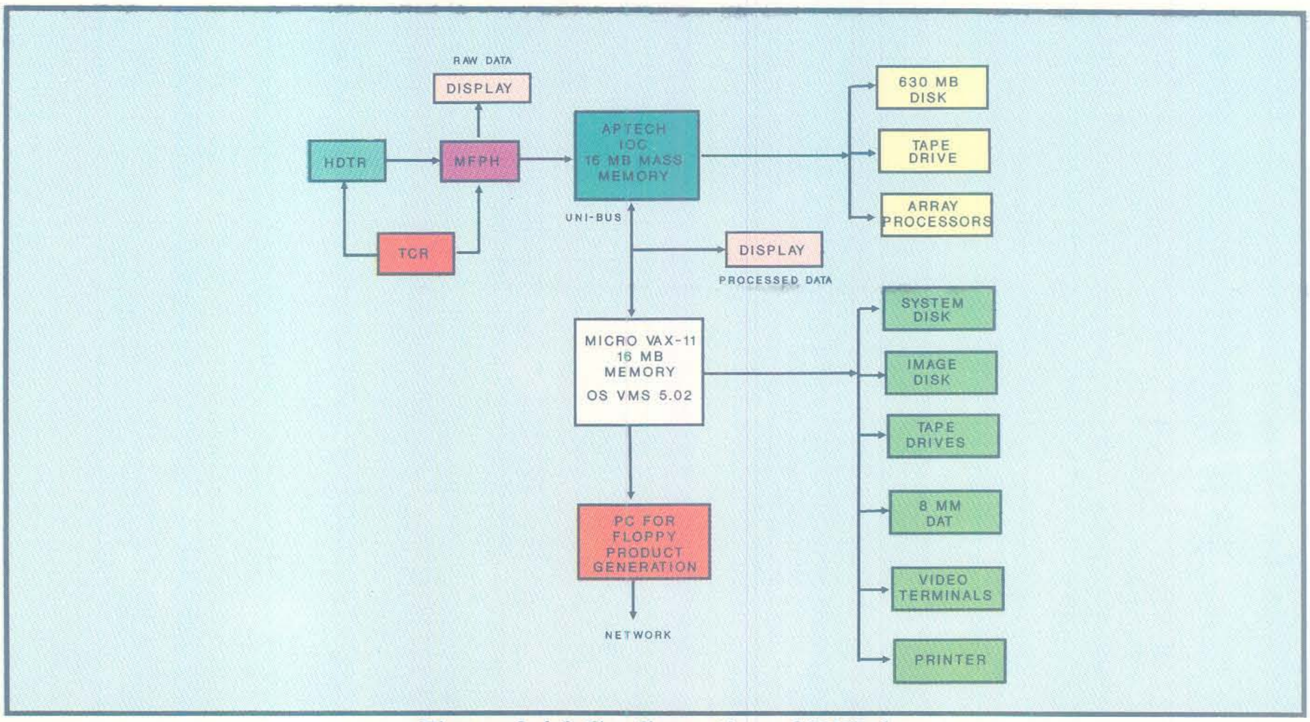


Figure 3.4.3 Configuration of DPS-1

Data processing system

Scheduling Strategy for DPS-1

Request queuing by IIMS to the DPS systems is done through the IIMS workorder file once the Master Scheduler is initiated.

Functions of Master Scheduler

i. Normal Request Queuing
  - System capability to generate specific product
  - HDDT dependency
  - Priority
  - Merging of multiple products of the same scene
  - Batching of multiple media products for same scene

ii. Priority Request Queuing
  - Out-of-turn assignment for urgent products

iii. Request to be generated on more than one DPS

iv. Initiation of jobs on multiple DPS systems for:
  - Swath model (DPS-1/2 and DPS-3)
  - DQE (generation on DPS-1/2 and DPS-3)
  - WiFS backdated requests (DPS-1/2 and DPS-3)

DPS-1 Scheduler

i. Normal Job Queuing
  - Descending priority
  - Requests of the same HDDT will be queued next
  - Batch queuing of multimedia requests
  - Queuing based on completion or operator request

ii. Priority job queuing :
  - Out-of-turn assignment for urgent products

3.4.3.2 Data Processing System - 2

The main functions of this systems are:

* Generation of Standard, Geocoded, Special and Stereo data products
* Diskload operation for Swath Modelling and diskload for WiFS backdated requests
* Floppy products generation on PC connected to DPS-2
* Intermediate DAT products generation for Cartridge products
* Distribution of work orders to DPS-2 or 3 for products generation through master scheduler when DPS-1 is down
* ACCT downloading for Browse processing and updating IMS database as a contingency

Configuration of DPS-2 is given in Figure 3.4.4.

3.4.3.3 Data Processing System- 3

The main functions of this system are:

* WiFS data processing
  - Radiometric correction for WiFS
  - Transfer to BPS and ACCEPTS for auto cloud cover estimation
  - Update full India VIM image on disk
  - Generate scene/zone based WiFS products and Zonal/Full India VIM products
  - Generate scene/zone based WiFS products and zonal VIM products for backdated data

* Data Quality Evaluation (DQE)
  - Digital product based radiometric and geometric DQE
  - Calibration DQE once per 24 day cycle
  - ACCT database DQE
  - LISS-III Histogram database

* Swath Modelling and Ground Control Points (GCP) Updation
  - Attitude model improvement using GCPs and updation of scene corner coordinates and attitude parameters and location accuracy flag in ACCT database at IMS
  - GCP library updating for PAN and LISS-III

Configuration of DPS-3 is given in Figure 3.4.5.

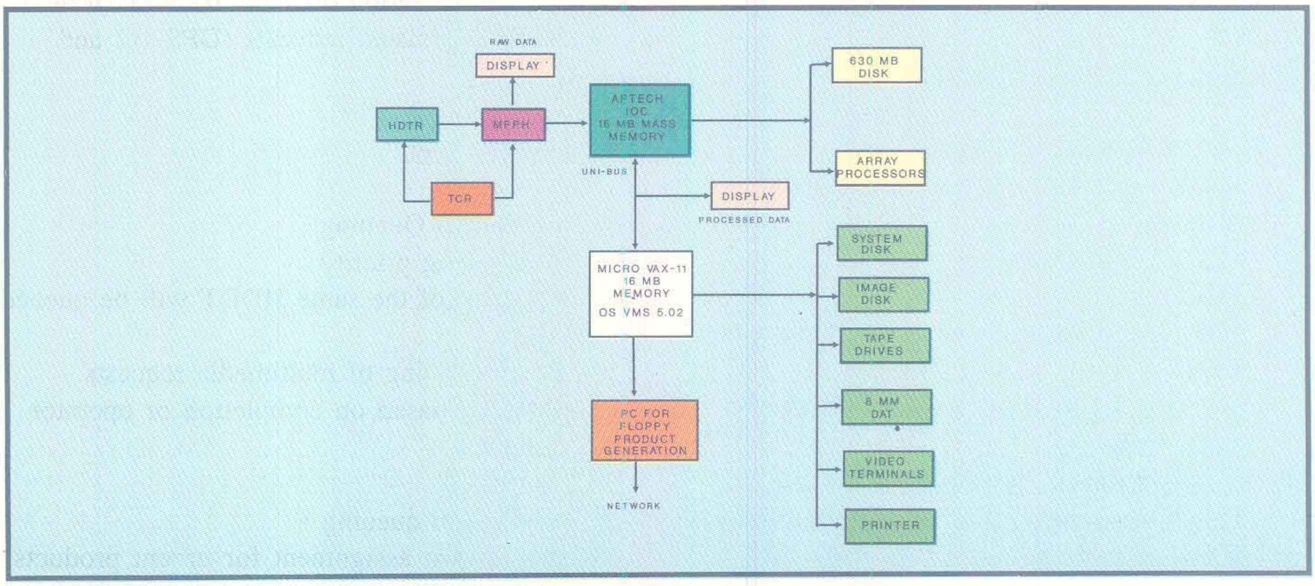


Figure 3.4.4 Configuration of DPS-2

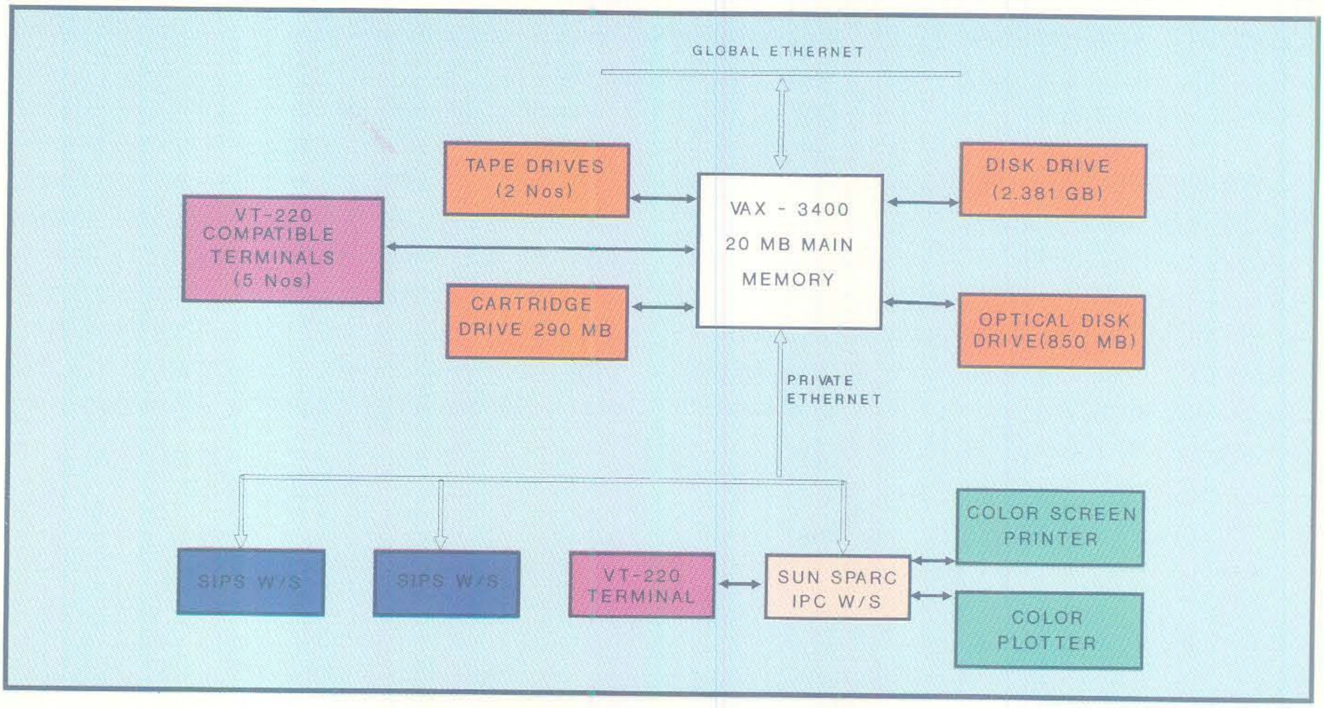


Figure 3.4.5 Configuration of DPS-3

3.4.3.4 Ground Control Points Library

Ground Control Points (GCPs) are points which are precisely identifiable in the geometrically uncorrected image data as well as on ground, or equivalently, on a large scale topographic map. GCPs are used for performing or evaluating geometric correction of image data.

To facilitate operational generation of highly precise geometrically corrected data products for IRS-1C/1D, an analog cum digital library of Ground Control Points is planned. The GCP library mainly consists of the following two data sets:

i. Ground coordinates of GCPs and
ii. Space images for digital GCP chip extraction and digital/manual GCP identification.

The basic library generation is done at SAC in collaboration with Survey of India, for finding GCP ground coordinates, and then installed at NRSA for operational use. The ground coordinates are found using any one of the following three methods.

i. From 1:25,000 toposheets
ii. office post pointing; and
iii.using GPS receivers.

The library contains around 1500 GCPs for LISS-III sensor covering the Indian landmass, generated from IRS-1B LISS-II data. In order to operationally use the GCP library, the digital GCP chips need to be updated with IRS-1C LISS-III/PAN data covering different seasons of the year. This GCP updation activity is carried out at NRSA during the first year of IRS-1C operations in DPS-3.

3.4.3.5 Swath Model

Conventional geometric correction methods model only the systematic errors, giving ground location accuracies of data products of the order of kilometer or two, for a scene. For the correction of random errors and generation of highly precise data products, GCPs are traditionally used on an individual scene basis.

For IRS-1C/1D, to operationally realise a highly precise geometric correction, a pass processing method, called 'Swath Model', is adopted which uses only a few precise GCPs spread over each pass. Modelling the pseudo-navigational or platform parameters using a few precise GCPs over the pass (or multiple scene segments), will result in location accuracies better than 200m in any scene.

The basic requirement for swath modelling is the availability of a GCP library, with accuracies commensurate with the resolution of IRS-1C/1D sensors. Swath modelling is a direct extension of precision processing scheme over multiple scenes. The knowledge of precise image and ground positions of a number of well distributed GCPs over a payload pass is being used as observations to model the low and middle order frequency components of orbit and attitude errors respectively over a time period of interest (approximately 15 minutes).

3.5 FILMING SYSTEM

The filming system is a centralised facility for generating B/W and color master film products for all satellites/sensors. The Filming system is equipped with B/W and Color FIRE-240 recorders for exposing 10" X 10" films. A Large Format Film Recorder is also available for exposing B/W films, B/W photographic paper and Color films of 40" X 40" size. This system uses Photo Compatible Tapes (PCT) generated at various Data Processing Systems for master film/ paper product generation.

Film Recorder

At filming system, film CCTs alongwith the IIMS work order for film/photographic paper products are received by the filming system from a DPS. A test target is filmed in each batch of the film production to verify the performance of the Film Recorder. Films are generated as per priority in IIMS work order. After updating IIMS work order, the exposed film is sent to photolab for processing alongwith a despatch report. The films rejected by Quality Control due to filming reasons are refilmed in subsequent batches and sent for photo processing. Configuration of the Filming System is given in Figure 3.5.1.

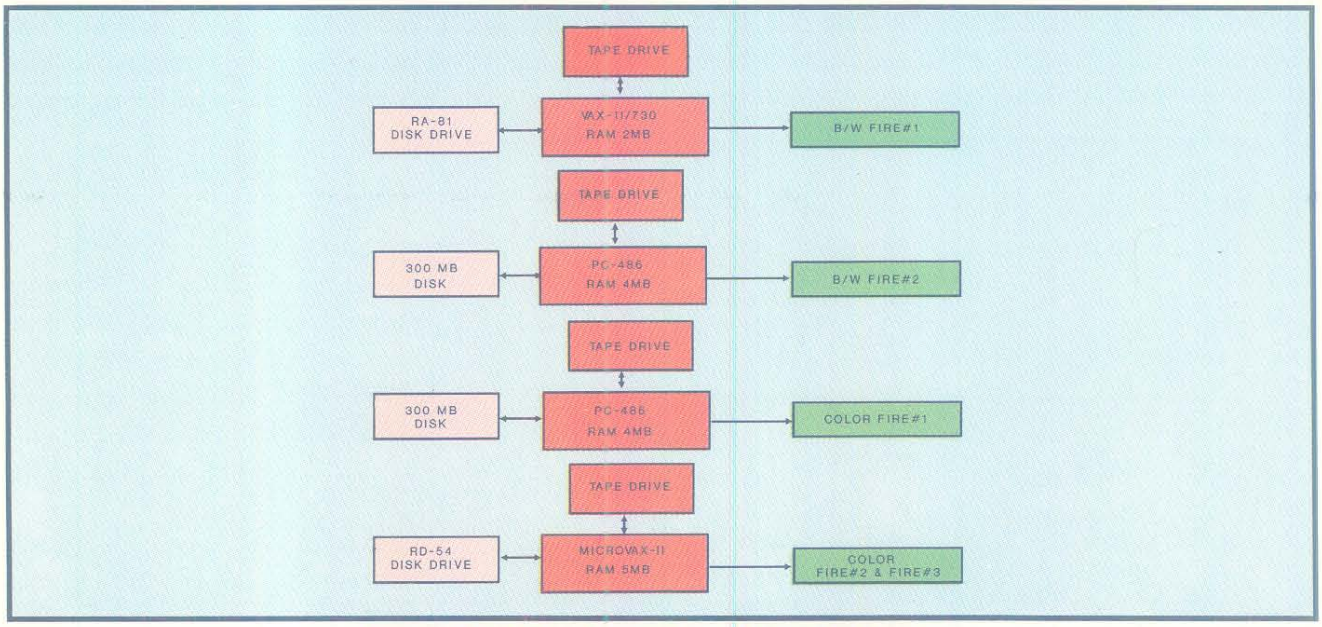


Figure 3.5.1 Configuration of Filming System

The various types of films/prints generated at the Filming System are :

* B/W negative film (10" X 10")
* FCC negative film (10" X 10")
* B/W negative film (40" X 40")
* FCC negative film (40" X 40")
* B/W positive paper (40" X 40")

3.5.1 FILMING LOOK-UP-TABLE (LUT)

LUTs are applied to image data to correct film,photo processing and photowrite non-linearities. Look Up Table is also used for enhancement of image data.

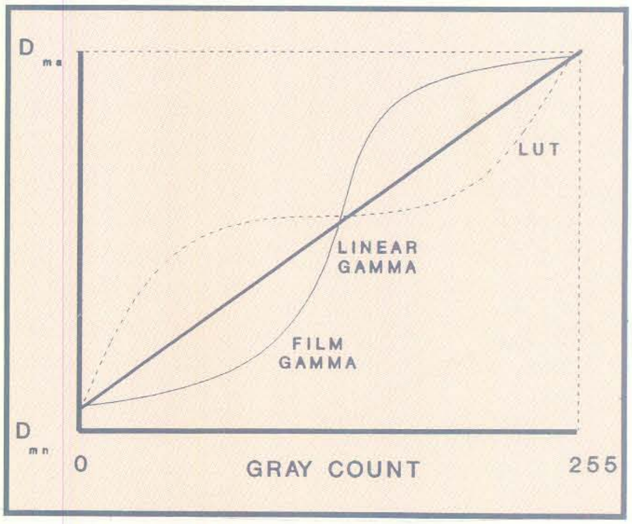


Figure 3.5.2 Film gamma correction

Film Gamma correction LUT

Linear Gamma Look Up Table is applied to image data for correcting the film, photo processing and Photowrite non linearities (Figure 3.5.2).

3.5.2 LARGE FORMAT PHOTOWRITE SYSTEM

In Large Format Photowrite System, large scale outputs can be obtained by exposing 40" x 40" B/W film or B/W paper or Color negative films. In conventional reproductions, due to the diffusion effect, the minor details are lost giving a rise to poor Moduler Transfer Function. In digital photowrite systems, higher MTF is obtained due to the inherent features built in the system. In digital image generation, as each pixel is exposed separately, higher MTF is achieved. Look-Up Tables are used for correcting film and processing characteristics and photowrite non-linearities. In this Film Recorder, the optics and electronics are so designed that one can have selectable aperture (spot size) of 50 or 100 microns. Since the spot size is already 2-5 times larger than the spot size

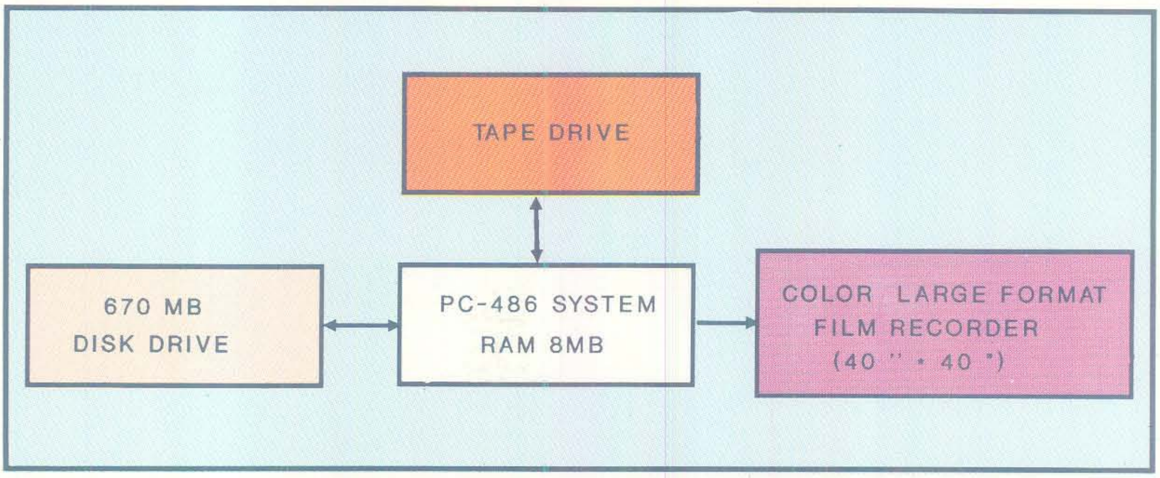


Figure 3.5.3. Configuration of Large Format Photowrite System

of small format photowrite systems, the enlargement is done at the pixel level. Though such a possibility does exist in small format photowrite systems wherein pixel is replicated a number of times and the image of 10" x 10" size is further enlarged using photographic enlarger, we get staircase effect due to quantisation. For IRS-1C data and also for any other high resolution sensor data, say, 10K pixels x 10K scan lines or more, one has to go in for a Large Format Photowrite System. The Photowrite System can expose data directly on RC B/W paper. Configuration of the system is given in Figure 3.5.3.

Features of Large Format Photowrite System

* Provides better contrast which aids in visual interpretation.

* Facilitates generation of full scene, high resolution satellite data of 10m at 1:50,000 scale. (Normally, small format film recorders are capable of producing images at 1:1000,000 or 1:250,000 scale)

* Facilitates generation of full scene data on 40" x 40" photographic B/W paper for better MTF (sharpness). This also reduces the effort in making prints from film.

* Useful for generating products from high resolution IRS-1C PAN data, and other products eg., VIM, Large District Geocoded products etc.

3.6 PHOTO PRODUCTS GENERATION SYSTEM

Photo Processing Laboratory is responsible for master film processing and generation of all B/W and Color photo products in the form of film transparencies and paper prints. It is equipped with modern photo processing and duplicating systems. It consists of :

* Master film processing systems
* Photo Printers and Enlargers
* Duplicate products processing systems

In the photo processing system, the exposed film is processed and the master image is sent for quality check at quality control. The products which qualify the quality criteria are routed to Photolab. Photolab takes the work order from IIMS, draws the required master from film archives and returns the same after the product is generated. The final products are sent for quality check to quality control work centre. Photo Processing system has a number of "In-Process Control" checks to ensure quality of outputs. For this purpose, sophisticated Sensitometric and Analytical tools are available. The function of various photographic systems are given in Table 3.6.1.

Figure.3.6.1 and 3.6.2 show the Photo Processing work flow of various data products.

Name of the System	Functions
Versamat film processor-I	240mm B/W master film processing
Hostert C-41 film processor	240mm Colour master film processing
LF Colenta C-41 processor	LF Colour film processing
LF Colex B/W film processor	LF B/W film processing
HK contact printer-I/II	B/W and Colour duplicate film generation
HK contact printer - III/I	B/W 1X print generation
HK 677/877 enlarger	B/W 2X enlargement
Colour enlarger	B/W 3X/3.6X enlargement
HK 877/677 enlarger	B/W 4X/5X enlargement
Hostert B/W paper processor	B/W 1X, 2X, 3X, 3.6X, 4X & 5X print processing
HK Contact printer - II/I	Colour 1X print generation
Durst 2000/2501 enlarger	Colour 2X enlargement
Colour enlarger	Colour 3X/3.6X enlargement
Durst 2501/2000 enlarger	Colour 4X/5X enlargement
Kreonite/Colenta EP-2 paper processor	Colour 1X, 2X, 3X, 3.6X, 4X & 5X print processing
LF Contact printer/LFColex B/W film Processor	LF B/W duplicate film generation
LF Contact printer/Hostert B/W paper processor	LF B/W contact print generation
LF Contact printer/Colenta C-41 film processor	LF colour duplicate film generation
LF Contact printer/Colour paper processor	LF colour contact print generation

Table-3.6.1 Functions of various photographic processors

Photo processing facility

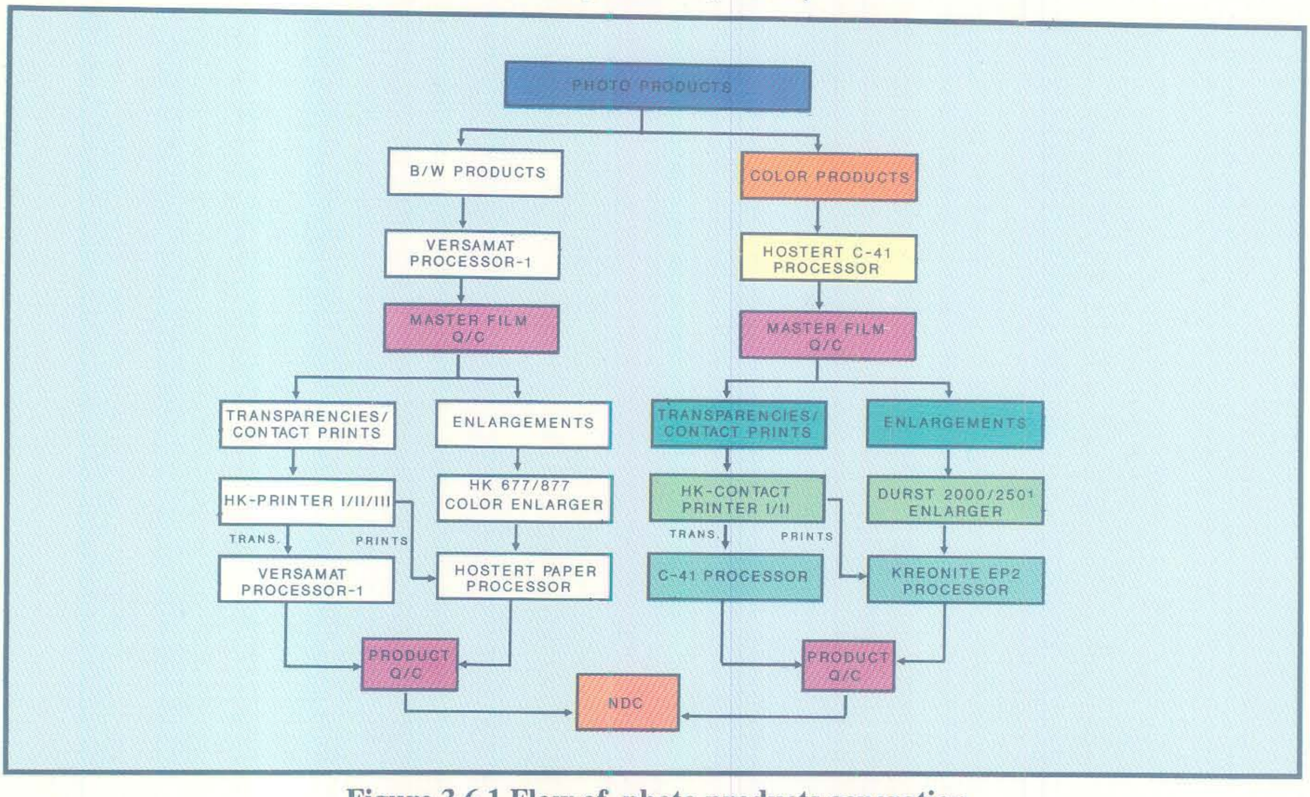


Figure 3.6.1 Flow of photo products generation

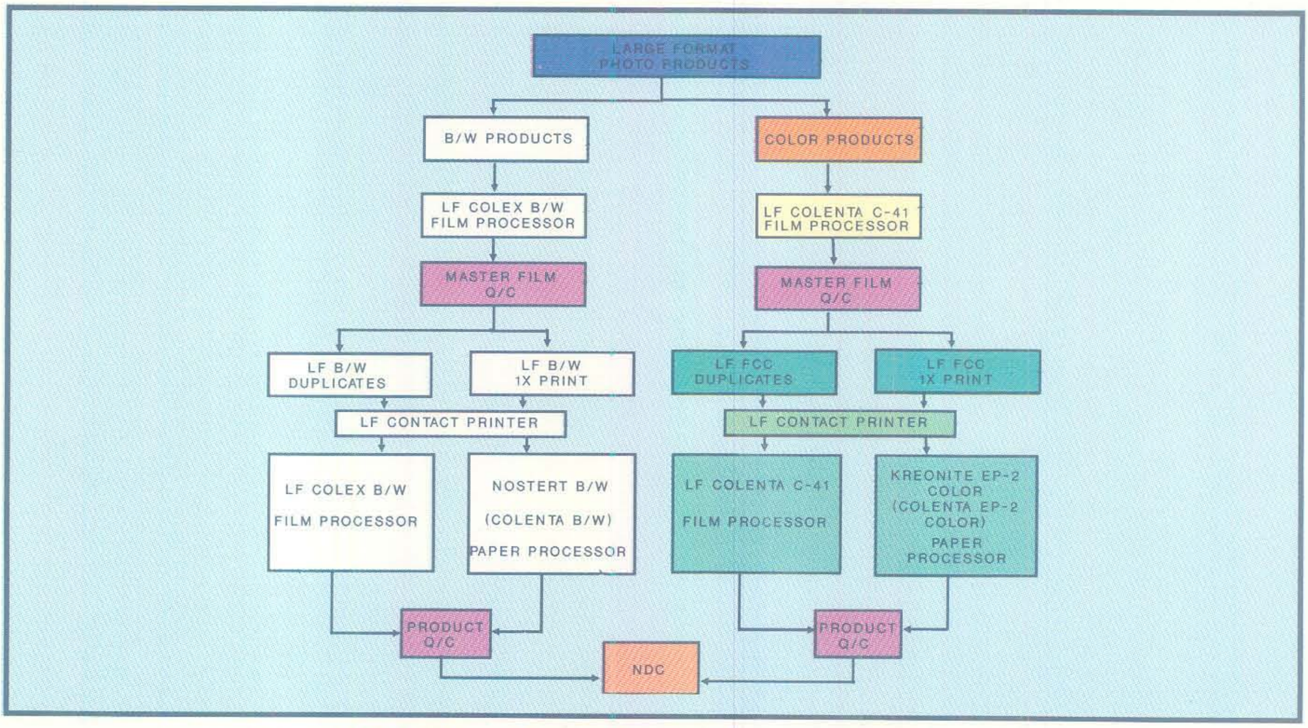


Figure 3.6.2 Flow of Large format photo products generation

3.7 DATA PRODUCT QUALITY

Best efforts are made to ensure that only good quality data products are sent to the users. The Quality Assurance System (QAS) consists of :

i. Raw data quality evaluation
ii. Data quality evaluation
iii. Quality assurance schemes for data generation.

Figures 3.7.1 to 3.7.2 depict the QAS. Tables 3.7.1 to 3.7.3 give the specifications of various photo products.

3.7.1 RAW DATA QUALITY EVALUATION

All the data acquired are evaluated for scene quality and cloud cover using automatic methods and later on verified manually using the Digital Browse.This information is available in the ACCESS catalouge.

3.7.2 DATA QUALITY EVALUATION

The primary function of DQE is to monitor the performance of the sensors and the stability of the platform. Data Quality Evaluation (DQE) can be broadly classified into

i. Radiometric DQE
ii. Geometric DQE

3.7.2.1 Radiometric DQE

The performance of the sensors are continuously monitored by Radiometric Data Quality Evaluation (RDQE). RDQE can be evaluated in two ways. i.e.

i. Calibration Analysis
ii. Scene Related Analysis

Calibration Analysis

The facility for inflight calibration is available for PAN and LISS-III as described in section 2.3.1

The calibration data is obtained from the satellite during night pass once in each cycle. This onboard calibration data will be compared with ground reference data. The parameters used in evaluation are:

i. Standard error between the onboard calibration data and ground reference data
ii. Temporal error between two successive onboard calibration data
iii. Dark current levels
iv. LED status

Scene Related Analysis

Spectral response of the sensor is evaluated by comparing spectral signature of various known terrains viz., Desert Sand, River Sand, Vegetation, Water, Barren Land, Urban area and Snow at different Sun Elevation Angles.

Scene related evaluation is carried out once in each cycle using Browse level digital data.

3.7.2.2 Geometric DQE

Geometric Data Quality Evaluation (GDQE) is done to know the following:

- Location accuracy of data products
- Band to Band misregistration
- Internal Distortions in a scene

These will be done using ACCT information and GDQE of acquired scenes.

3.7.3 QUALITY ASSURANCE SCHEME FOR DATA PRODUCTS

All production centres of IRS-1C satellite data products generation have inbuilt In Process Centre

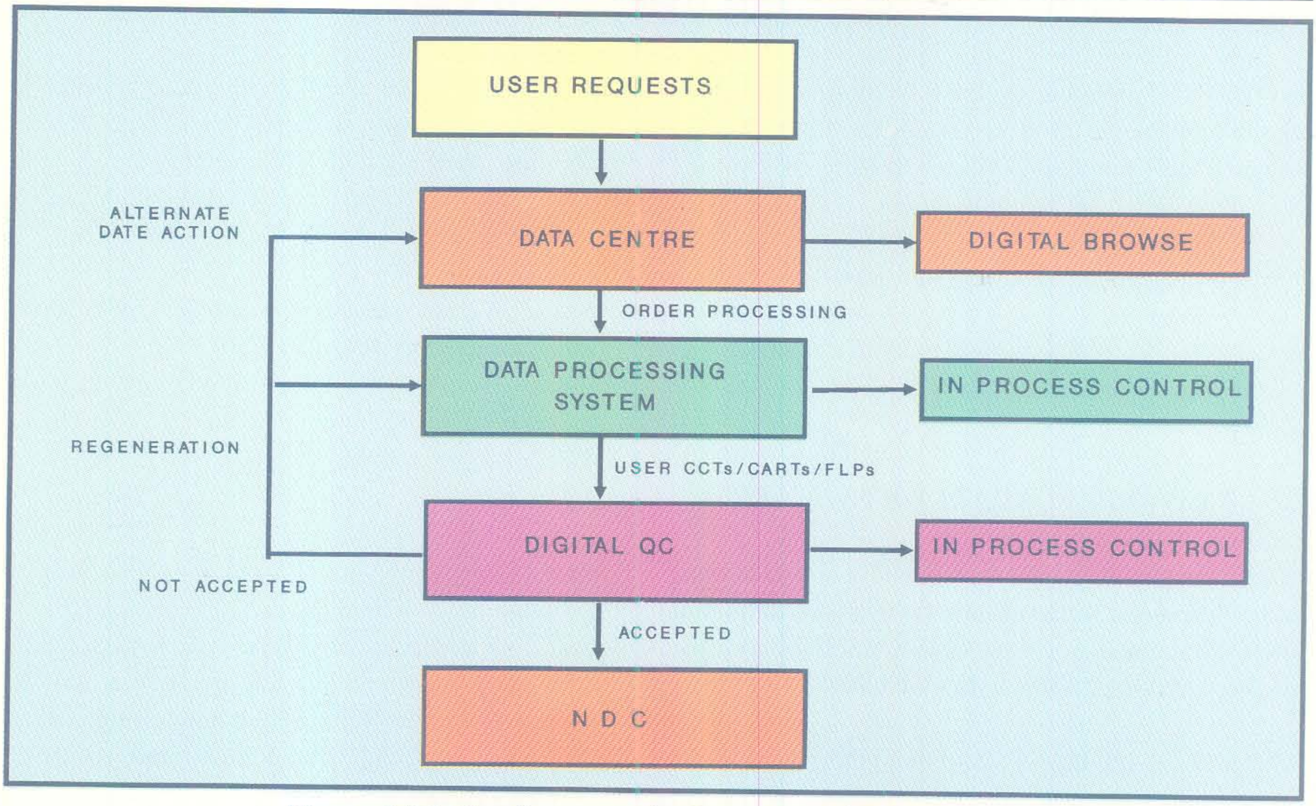


Figure 3.7.1 Quality control scheme for digital products

PARAMETER	B/W	FCC
Dmax	1.75 ± 0.10	0.95 ± 0.05
Dmin	<or = 0.15	0.25 R 0.65 G 0.85 B
Colour balance	—	< or=0.05D at 0.60D above B + F
Linearity at G scale	< or= 6% at Dmax	<or=8% at Dmax
Density Uniformity	<or=0.08 at 0.8D above B+F	<or = 0.05 at 0.6 D above B+F
Modular Transfer Function	>or=75% for 17 cycles/mm	>or=60% at 17 cycles/mm
Physical dimension	<or= 0.1%	<or=0.1%
Registration	—	half pixel

Table 3.7.1 Specifications of Photomaster

Quality Control facility

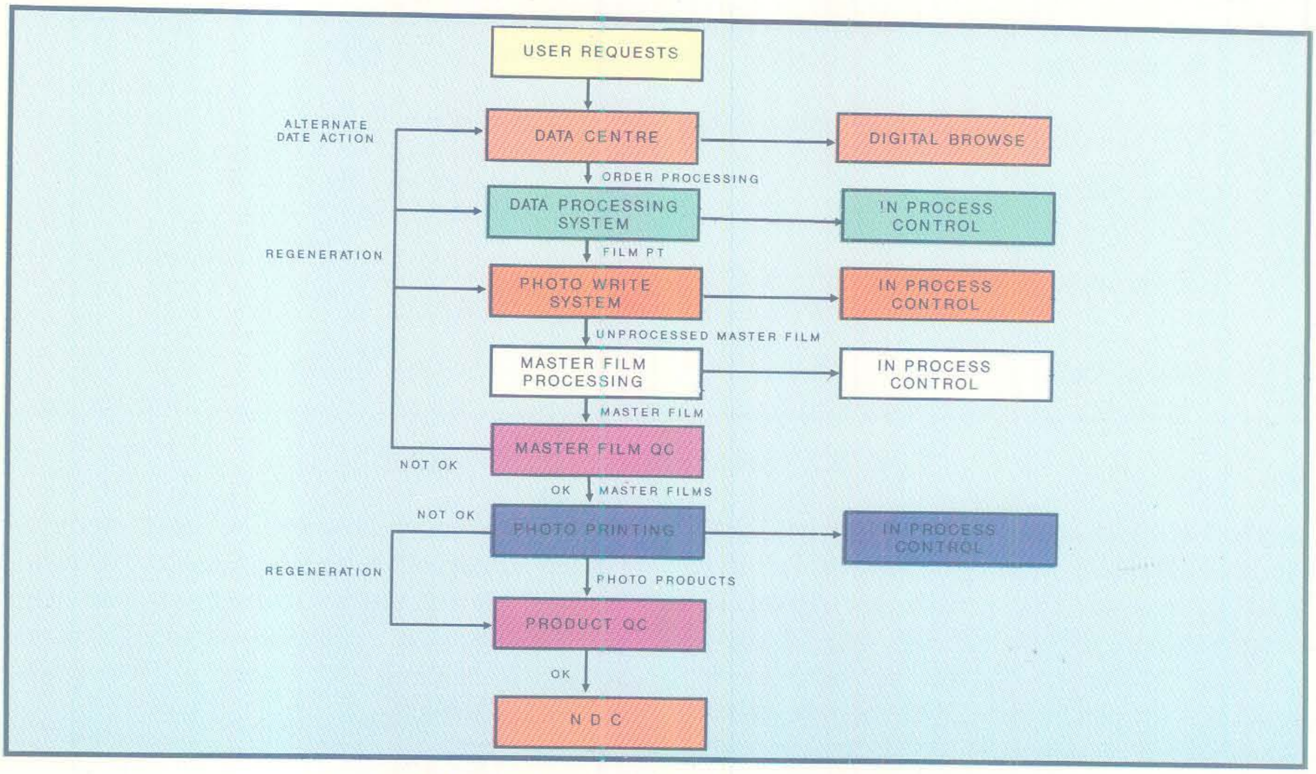


Figure 3.7.2 Quality control scheme for photoproducts

PARAMETER	B/W	FCC
Dmax	1.75 ± 0.10	>or= 2.20
Dmin	<or=0.15	<or=0.15
Colour balance	---	<or = 0.1D at 1.0D above B + F
Denisty uniformity	<or=0.08 at 0.8D above B + F	<or = 0.05 at 0.6D above Dmin
Modular Transfer Function	>or=60% for 17 cycles/mm	>or=65% at 17 cycles/mm
Physical dimension	<or=0.1%	<or=0.1%
Registration	—	half pixel

Table 3.7.2 Specifications of phototransparencies

PARAMETER	B/W	FCC
Dynamic Range	1.60 ± 0.10	2.5 ± 0.2
Dmin.	<0r = 0.15	<or = 0.15
Colour balance	—	<or = 0.1D at 1.0D above B + F
Density uniformity	<or = 0.15 at 0.8D above B + F	—
Physical Dimension	<or = 0.15%	< or = 0.15%

Table 3.7.3 Specifications of photoprints

by which all the equipment identified for production work are certified for quality outputs. Fig. 3.7.2 and 3.7.3 depicts the QC scheme for digital and photographic products. In the case of digital products, PC based systems are used for the inspection of data.For photoproducts, the masters are inspected for data acquisition,data processing and filming/photoprocessing problems. Accepted masters are kept in Master Film Archives (MFA) for further photo reproductions as per user requirements. The duplicate photoproducts are subjected to final QC inspection for photo duplication quality.

3.7.4 GENERAL SPECIFICATIONS

i. Location accuracy should be less than or equal to 2.2 Km (RMS) for IRS-1A/1B and 1.5Km (RMS) for IRS-1C.

ii. Product should be free from severe vertical striping.

iii. Data loss should not exceed one scan line

iv. Scattered Pixel dropouts should not affect more than 5% of the total image area.

v. There should not be any image distortions affecting the continuity of data.

3.7.5 PHOTO PRODUCTS SPECIFICATIONS

All IRS photo products should conform to the following criteria alongwith the above general specifications:

i. Film Recorder problems such as microbanding, seating problem, recorder lines, fog, scratches etc., should not affect the interpretability of the image and aesthetic quality of the image.

ii. Photo Processing defects such as roller marks, scratches, fog, dust, finger prints, inks etc., should not affect the interpretability and aesthetic quality of the image.

iii. There should be sufficient image contrast so that the photographic duplicate can be interpreted easily.

3.7.6 DIGITAL PRODUCT SPECIFICATIONS

Digital products should conform to the following specifications:

i. Should be free from severe vertical striping.

ii. Data loss should not exceed one scan line.

iii. Scatterred pixel dropouts should not affect more than 5% of the total image area

iv. Digital products should be free from physical damages and be readable in a system other than the one available in production unit.

v. Digital product should conform to NRSA digital product format document.

However, considering the volume of data products generated, it is possible that a defective product may be supplied to the user. In such cases, the products may be returned to NDC for replacement, free of cost. It should however be noted, that, the quality of reproduced product can never exceed the quality of the master reproducible in the archives.

3.8 ARCHIVES

The Archives work centre is responsible for receiving and archiving HDTs and Photographic master films. The HDTs and master films are issued to a workcentre on request and are replaced on completion of the job.

The functions of HDT and Photo master archives are described below:

HDT Archives

- Receipt of HDTs from Shadnagar
- Archival of HDTs in sequential order, maintaining proper environment
- Issuing the required HDTs to DPS
- Replacing HDTs received back from DPS
- Cleaning the HDTs periodically
- Periodic cleaning and evaluation of photowrite compatible tapes

Photo Master Archives

- Archival of photo master films of different satellites
- Maintenance of proper environment
- Issuing the masters on Photolab request
- Replacing masters received back from Photolab
- Deletion of degraded masters.

3.9 INTEGRATED INFORMATION MANAGEMENT SYSTEM (IIMS)

IIMS is an endeavour in the direction of automation when manual methods are highly difficult to handle large amount of acquired data, different types of data products from various satellites and stringent turn-around-time requirements.

IIMS is a coordinated system that handles the entire sequence of operations, right from the moment an order is received, till the product is despatched. IIMS manages the accession information of various satellites, automates all the functions of user order/ request processing, user accounting, monitoring, archival, costing and billing of the data products.

IIMS system is built around DEC-Alpha 3000 model 600S having 2MB Cache and 96MB main memory with 5GB disk space. The operating system chosen is VMS-AXP and the data base software is DEC RDB. Configuration of the IIMS system is given in Figure 3.10.1

The main functions of IIMS are :
* Management of the acquired data
* Generation of accession catalogue
* Proforma processing
* User order/Request processing
* Priority of data products generation
* User Account/Billing management
* Various reports for monitoring the production status of the products
* Dynamic scheduling of data requests to a system
* Work-orders for various work center
* Updation functions for each work center
* HDT/CCT/Film Archives Management
* Production Management
* Accounting in Indian and Foreign currency
* Statistics on data usage by users etc.,.

In addition to the above functions, the following functions are included for IRS-1C :
* Interfacing with Swath Modelling operations
* Interfacing with Digital Browse System
* Interfacing with ACCESS Expert System
* Interfacing with DQE System
* Pass Programming operations

The system handles different products like
* CCT (1600 bpi, 6250 bpi)
* DAT
* Floppy (1.44 MB)
* Cartridge (150/525 MB)
* Transparency (Black and White, FCC)
* Paper Print (Black and White, FCC)

The various work centers involved in the production chain are
* NRSA Data Centre
* Data Processing System
* Filming System
* Photo Processing System
* Photo Lab
* Quality Control
* Archives

The work centers involved in the production of different products are different. Also, the work flow differs depending upon whether the data requested is available or not.

The data product generation involves several complex sequence of operations and the data product flow is based on the satellite, sensor, product type, format and media. All this is achieved through the efficient computerised IIMS. Figure 3.9.2 shows the information flow between the IIMS and various work centres.

Various queries regarding data availability, quality of the data available and area coverage for the user specified requests are handled by NDC using the utilities provided by IIMS.

Information Management System

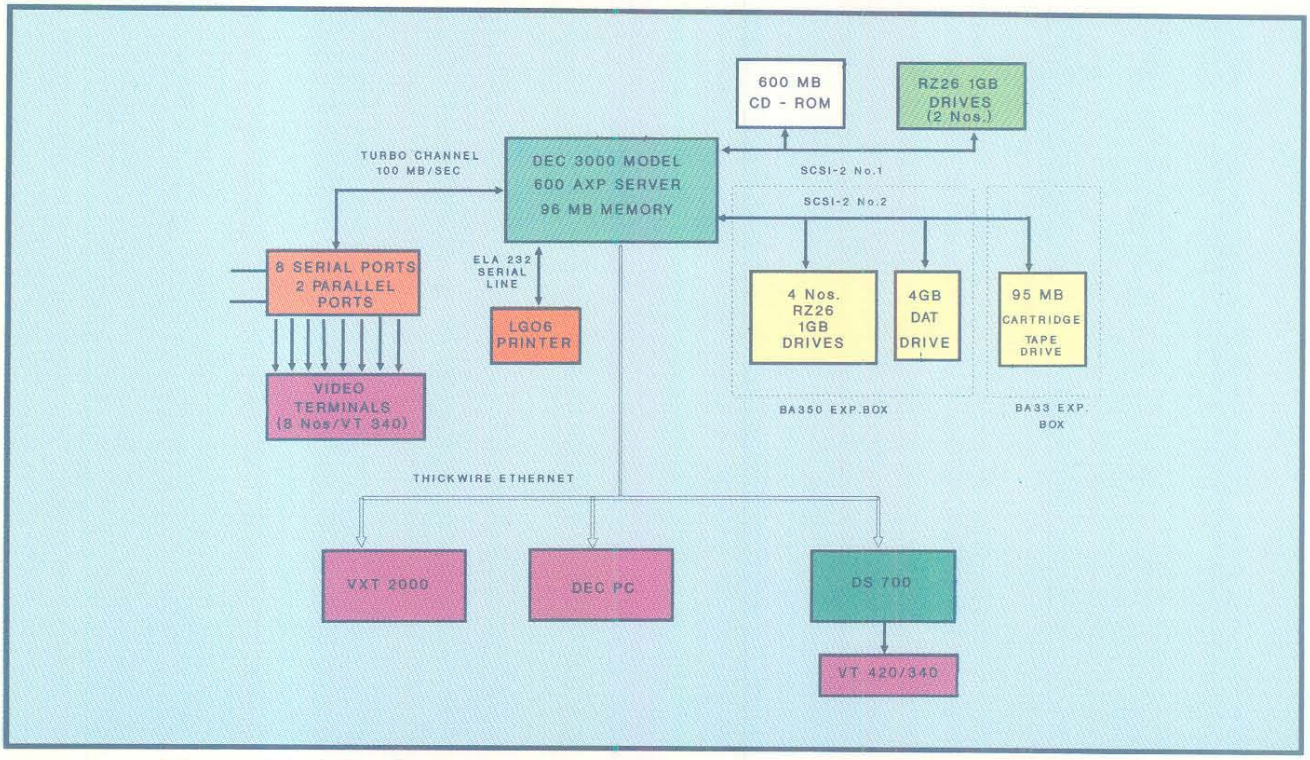


Figure 3.9.1 Configuration of Integrated Information Management System

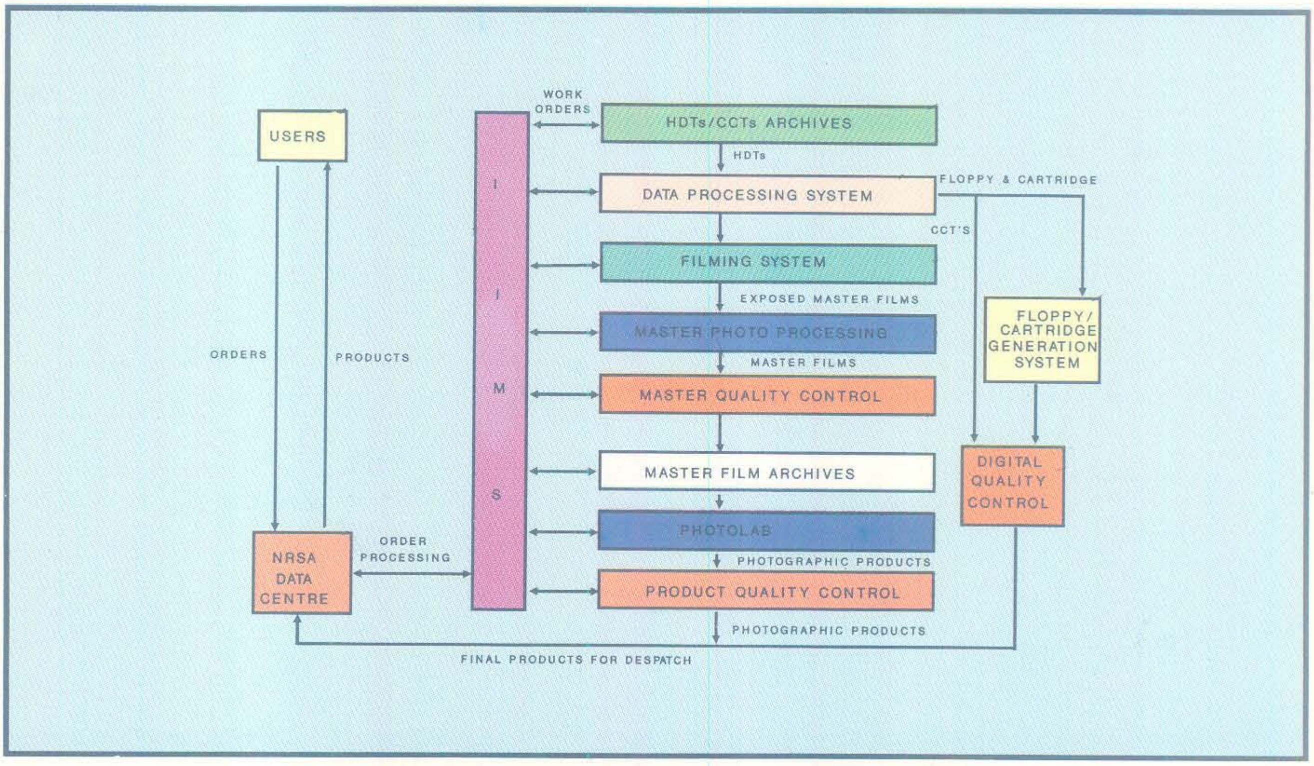


Figure 3.9.2 Flow diagram of data products generation through IIMS

4. DATA PRODUCTS

4.1 INTRODUCTION

This Chapter describes the IRS-1C referencing scheme and the various types of data products that will be made available to the users. The referencing scheme is discussed in Section 4.2. The various types of products that are generated at the IRS DPS are described in Section 4.3. These include the path-row based, shift-along-track, quadrant and special products. The path-row based products are generated on the basis of the IRS image referencing scheme and are available on both photographic and digital media. The shift-along-track products are generated by sliding the standard scene along the track.

Apart from the regular products, a number of special products like Vegetation Index Maps and District Geocoded products are also being made available to the users.

4.2 REFERENCING SCHEME

4.2.1. INTRODUCTION

Referencing scheme which is unique for each satellite mission, is a means of conveniently identifying the geographic location of points on the earth. This scheme is designated by Path and Rows. The Path-Row concept is based on the nominal orbital characteristics. This section describes the referencing scheme and related information.

4.2.2 PATH

An orbit is the course of motion taken by the satellite in space and the ground trace of the orbit is called a 'Path'.In a 24 day cycle, the satellite completes 341 orbits with an orbital period of 101.35 minutes. This way, the satellite completes approximately 14 orbits per day. Though the number of orbits and paths are the same, the designated path number in the referencing scheme and the orbit number are not the same. On day one (D1), the satellite covers orbit numbers 1 to 14, which as per the referencing scheme will be path numbers 1, 318, 294, 270, 246, 222, 198, 174, 150, 126, 102, 78, 54 and 30, assuming that the cycle starts with path 1. So orbit 1 corresponds to path1, orbit 2 to path 318, orbit 3 to path 294 etc.,. The fifteenth orbit or first orbit of day two (D2), is path 6 which will be to the east of path 1 and is separated from path 1 by 5 paths.

Path number one is assigned to the track which is at 29.7 deg West longitude. The gap between successive path is 1.055 deg. All subsequent orbits fall westward. Path 1 is so chosen, that, the pass with a maximum elevation greater than 86 deg for the data reception station of NRSA at Shadnagar can be avoided. This is due to the limitation of antenna drive speed, since, it is difficult to track the satellite around zenith. In fact, above 86 deg elevation, if a pass occurs, the data may be lost for a few seconds around zenith. Hence, the path pattern is chosen such that, the overhead passes over the data reception station is reduced to a minimum. To achieve this, path 1 is positioned in such a manner that the data reception station is exactly between two nominal paths, namely 99 and 100. During operation, the actual path may vary from the nominal path pattern due to variations in the orbit by perturbations. Therefore, the orbit is adjusted periodically, after certain amount of drift, to bring the satellite into the specified orbit.

The path pattern is controlled within ± 5 Km about the nominal path pattern. Due to this movement of actual paths within ± 5 Km about the nominal path, it is not possible to totally avoid above 86 deg elevation passes for Hyderabad. However, with this approach, the number of passes above 86 deg elevation is reduced to almost one in a 24 days cycle.

4.2.3 ROW

Along a path, the continuous stream of data is segmented into a number of scenes of convenient size. While framing the scenes, the equator is taken as the reference line for segmentation. The scenes are framed in such a manner that one the scene's centre lies on the equator. For example, a LISS-III scene., consisting of 6000 lines, is framed such that the centre of the scene lies on the equator. The next scene is defined such that its centre lies exactly 5,703 lines from the equator. The centre of next scene is then defined 5,703 lines northwards and so on. This is continued upto 81 deg North latitude. The lines joining the corresponding scene centres of different paths are parallel to the equator and are called Rows. The uniformly separated scene centres are, such that, same rows of different paths fall at the same latitude. The row number 1 falls around 81 deg North latitude, row number 41 will be near 40 deg North and row number of the scene lying on the equator is 75. The Indian region is covered by row numbers 30 to 90 and path numbers 65 to 130.

4.2.4 SCENE DEFINITION

The camera scans the ground track line by line continuously. The satellite motion along the track provides continuous imaging of the ground. This continuous stream of data is segmented to convenient sizes. These segments are called scenes. The camera system takes certain amount of time to read and register the CCD array data. This integration time is chosen prior to launch and is fixed throughout the mission. The integration time for each camera is so chosen, that, it is equivalent to the time taken by the satellite in nominal orbit to traverse the scan line distance of the respective cameras. The across track width is limited by the swath of the respective cameras. Due to the line-by-line mode of scanning, the along track scan is a continuous strip and is divided into a number of uniform scenes.

Each line of the camera consists of a fixed number of CCD elements in the form of an array. The image obtained by one CCD element is a pixel. The pixel size on ground is equal to the resolution of the respective cameras. The across track length of the scan (swath) is determined by the pixel size and number of elements in a line. Each imaging sensor scans line by line during its integration time, which is fixed for each camera. Thus, each camera scans a fixed number of lines in fixed intervals of time. Therefore, the along track length of a scene is based on the number of lines used to constitute that scene.

4.2.5 USE OF REFERENCING SCHEME

The Path-Row referencing scheme eliminates the usage of latitude and longitudes and facilitates convenient and unique identification of a geographic location. It is useful in preparing accession and product catalogues and reduces the complexity of data products generation.

Using the referencing scheme, the user can arrive at the number of scenes that covers his area of interest. However, due to orbit and attitude variations during operation, the actual scene may be displaced slightly from the nominal scene defined in the referencing scheme.Hence,if the user's area of interest lies in border region of any scene, the user may have to order the overlapping scenes in addition to the nominal scene.

4.2.6 COMPARISION BETWEEN IRS-1A/1B AND IRS-1C REFERENCING SCHEME

The Referencing Scheme of IRS-1C is different from that of IRS-1A/1B. In the IRS-1C referencing scheme, the adjacent path occurs after five days and not on the next day as in the case IRS-1A/1B. This type of referencing scheme has been chosen keeping in view the PAN sensor, so that, the revisit capability of 5 days can be met. Table 4.2.1 gives the major differences in terms of referencing scheme pattern of IRS-1C from IRS-1A/1B.

	IRS-1A/1B	IRS-1C
Altitude	904 Km.	817 Km.
Repetivity	22 days	24 days
Consecutive path	D + 1 day	D + 5 days
Numbering of paths	East to West	West to East
Total number of orbits/cycle	307	341

Table 4.2.1 Difference in referencing scheme pattern of IRS1C and IRS1A/1B

Since the sensors have different swath widths, it is required to have a different referencing scheme for each of the sensor.

4.2.7 LISS-III REFERENCING SCHEME AND SCENE COVERAGE

The swath of LISS-III is 141km in visible and near infra-red bands and 148km in Short Wave Infra-Red (SWIR) band. Since the swath of LISS-III in all the four bands is greater than the inter-orbit distance (117.5km), the sensor scans the entire globe once in every cycle without gaps. The referencing scheme of LISS-III consists of 341 paths numbered from west to east. Each path consists of 149 rows. Consecutive paths are covered with a separation of five days. If Path 1 is covered on day one, Path 2 will be covered on day six (Figure 4.2.1).

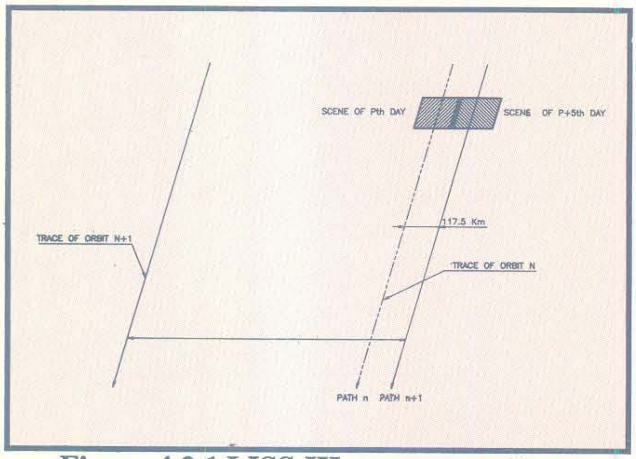


Figure 4.2.1 LISS-III coverage pattern

Each LISS-III scene of visible and near infra-red bands covers an area of 141Km x 141Km. In the case of LISS-III SWIR band, the area covered is 148 Km x 141 Km. The side lap between two LISS-III (V, NIR) scenes is 23.5Km at the equator and for SWIR band it is 30.5. The overlap between successive scenes in a path is 7 Km. The SWIR band coverage in a LISS-III (V,NIR) scene is shown in Figure.4.2.2

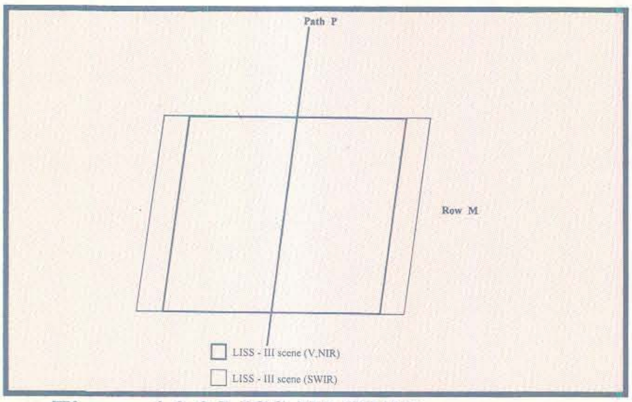


Figure 4.2.2 LISS-III SWIR scene over LISS-III (V,NIR) scene

4.2.8 PAN REFERENCING SCHEME AND SCENE COVERAGE .

As already mentioned in Chapter 3, the PAN camera consists of three CCD arrays. Each array in turn consists of four ports. The data from the sensor is formatted into two serial PCM streams called I and Q. The data from the four ports of first CCD array and ports one and two of the second CCD array are multiplexed and formatted to stream I. The data from the four ports of the third CCD array and ports three and four of the second array are multiplexed and formatted into the 'Q' stream. So I+Q streams put together form the PAN full scene. The total swath of the three arrays of detectors put together is only 70km when viewed in the nadir mode. This leads to gaps because the distance between any two orbits (paths) is 117.5km. So, provision has been made to steer the camera by ± 26 deg. By tilting the camera, entire globe can be covered, though not in the same cycle.

The referencing scheme of PAN has been evolved around the LISS-III scene centre,Further, each LISS-III scene can accommodate four PAN full scenes designated as A, B, C and D. The PAN scenes will be referred to by the same path and row numbers as that of LISS-III alongwith the suffixes A, B, C and D (Figure 4.2.3). It is to be noted that this layout for

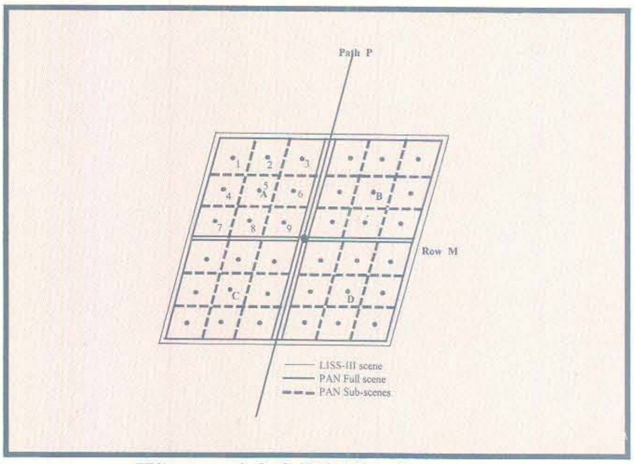


Figure 4.2.3 PAN subscenes

PAN is chosen for referencing scheme only. An overlap of 1 Km. is assumed between A & C and B & D in the referencing scheme. The side lap between A & B and C & D is assumed to be 1 Km.

It is possible to process the data CCD array wise. This has lead to the concept of PAN subscenes as in the case of IRS-1A/1B LISS-II. A PAN scene consists of nine subscenes and each is of the dimension 23.5Km x 23.5Km.

The configuration of PAN camera is such that, in the Nadir view, the PAN scene center will fall in the ground trace of LISS-III as shown in Figure 4.2.4.

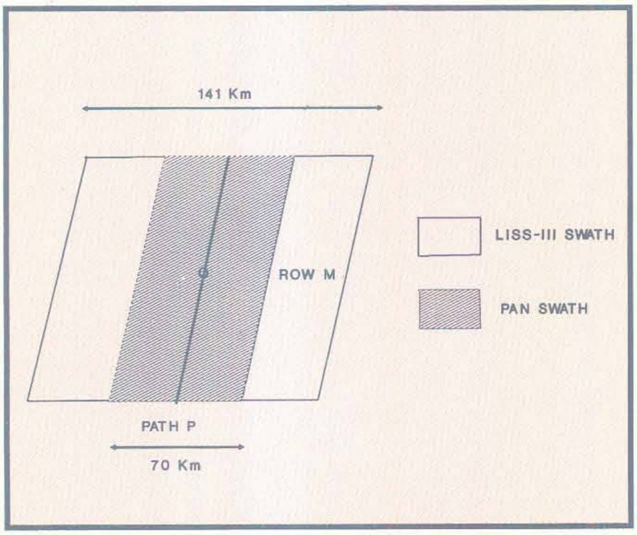


Figure 4.2.4 PAN scene (Nadir)

It is evident that scene A & B are partially covered in the Nadir, hence, in actual practice, because of the steerability, the data corresponding to scene A & C (or) B & D are acquired fully by tilting the camera at an angle of ± 2.4 deg from nadir.

4.2.9 WIFS REFERENCING SCHEME AND SCENE COVERAGE.

The WiFS referencing scheme is also based on LISS-III scene centre. However, due to large coverage of each WiFS scene (810km x 810km), there is an overlap of 85% i.e., 692.5km between adjacent paths. Similarly, the overlap between adjacent rows is 676km. So, if a user requires continuous area, say, 1200km x 1200km, it is enough if he orders for four WiFS scenes. The point to be noted here, is that, the user should order data pertaining to path P and path P+5 (which is covered on the next day) and rows R and R+5 of paths P and P+5 to cover his entire area. This way user gets data pertaining to his area within two days (Figure 4.2.5).

The huge overlaps between the WiFS scenes of adjacent paths results in repeated coverage of the same area in a given cycle. A given scene can be covered completely on its day of pass and also by a combination of two scenes acquired on different days during the cycle.

Take again path P1 which is covered on day D1. The area pertaining to Path P1 can also be covered by the following combinations of paths acquired on various days during the cycle.

Combination of paths	Day of the cycle
P2 - P337	6th and 24th
P2 - P338	6th and 5th
P2 - P339	6th and 10th
P2 - P340	6th and 15th
P2 - P341	6th and 20th
P3 - P338	11th and 5th
P3 - P339	11th and 10th
P3 - P340	11th and 15th
P3 - P341	11th and 20th
P4 - P339	16th and 10th
P4 - P340	16th and 15th
P4 - P341	16th and 20th

This is the case at the equator. Since at higher latitudes the overlap is more, the coverage becomes more frequent.

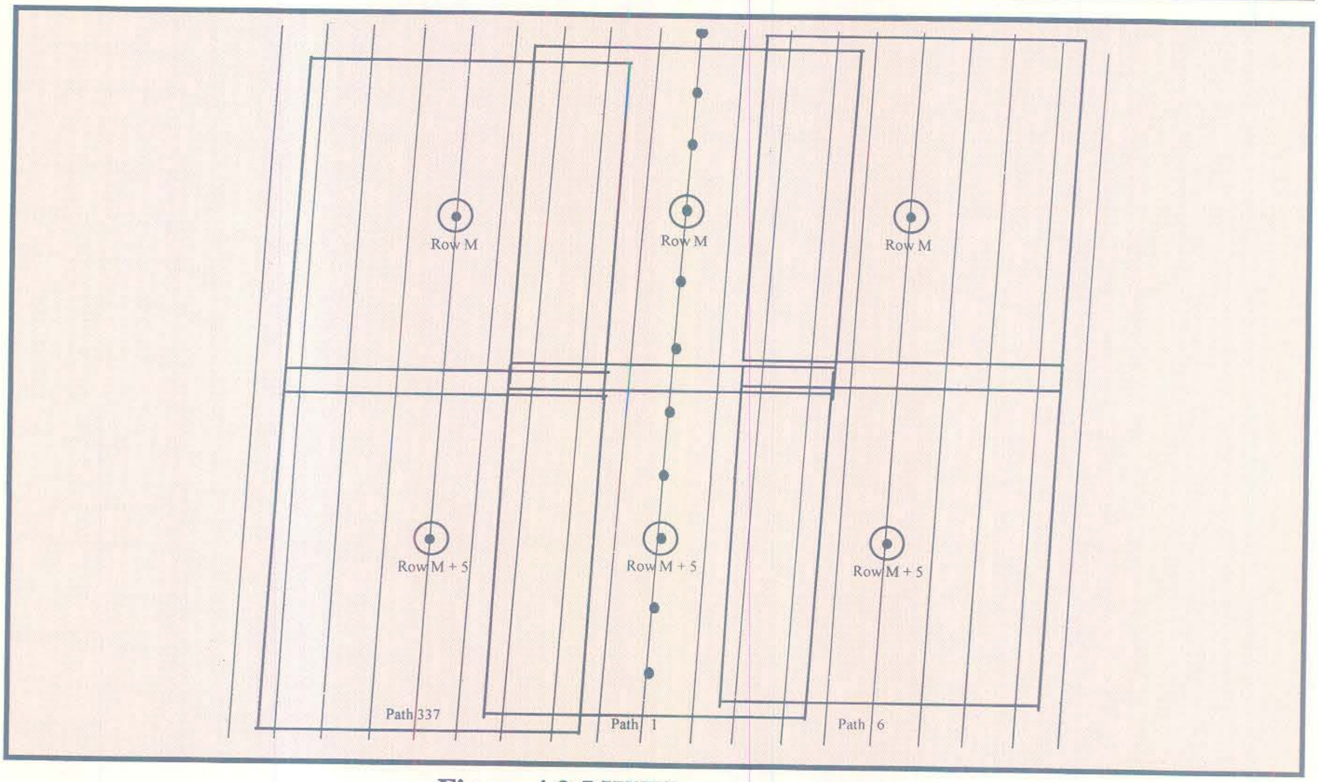


Figure 4.2.5 WiFS scene coverage

4.2.10 INDIAN AND WORLD REFERENCING SCHEME MAPS

The following referencing scheme maps are available for users reference:

i) India and neighboring countries on 1:6,000,000 scale
ii) Six zones of India, namely, Central, North, South, East, West and Andaman Nicobar, on 1:4,500,000 scale
iii) The entire coverage of Hyderabad earth station on 1:12,800,000 scale

A world referencing scheme map is produced for ready reference of path and row numbers over the total coverage of IRS on land and water from 81°N to 81°S. The map is produced in mercator projection. The scale of this map is 1: 62 million.

The referencing scheme map of following world zones are also available on larger scales: Asia, Europe, North America,. Africa, Australia and Antarctica.

4.2.11 DETERMINATION OF OBSERVATION DATES

For the chosen path, the ground track repeats every 24 days after 341 orbits. Therefore, the coverage pattern is almost constant. The deviations of orbit and attitude parameters are controlled within limits such that the coverage pattern remains almost constant through out the mission. Therefore, on any given day, it is possible to determine the orbit which will trace a designated path. Once the path is known, with the help of referencing scheme, it is possible to find out the region covered by that path. Therefore, an orbital calendar, giving the details of paths, covered on different days will be helpful to users to plan their procurement of satellite data products.

Considering a typical path calendar (Table 4.2.2), assuming that path number 1 starts on January first, if data over a geographic area covered by path 60 is required, it is seen that this path is covered on days, 3rd of January, 20th of February, 16th of March and so on. Thus, it is possible to know on which day the required data has been collected or is going to be collected.

4.2.12 ESTIMATION OF PATH AND ROW, LOCAL CLOCK TIME AND OTHER DETAILS FOR ANY POINT ON INDIAN SUB-CONTINENT

The procedure outlined below may be used to determine the path and row, Greenwich Meridian Time (GMT) and the local clock time when the satellite passes over any point in the Indian sub-continent.

i. Define the latitude and longitude of the point of interest over Indian region.

ii. Determine the approximate descending node as follows:
   1. Locate the latitude of the point of interest in Table 4.2.3. Table 4.2.3 gives the longitudinal difference from the given longitude to the descending node longitude as a function of latitude.
   2. Read the value of longitude from this table. If the latitude falls within two values, then, interpolate and get required longitude.
   3. Add this value to the longitude of the point of interest, to get rough estimate of descending node longitude.

iii. The actual descending node details are obtained as follows:
   1. Table 4.2.4 gives the descending node longitude of all paths over Indian region. Find the path, nearest to the longitude computed in step ii. This gives the path number and descending node longitude of the path.
   2. Table 4.2.5 gives the descending node time (GMT) expected for each path over Indian sub-continent.

iv. GMT at the point of interest is found as follows:
   1. Given a latitude, using the nominal inclination of the orbit, the time of descending node can be calculated
   2. Add the time to the GMT of the descending node as obtained in step iii, by carefully noting the algebraic sign.

v. The Indian Standard Time (IST) is obtained by adding five and a half hours to the time (GMT) obtained in step iv.

vi. Table 4.2.3 gives the row numbers versus latitude. Find the nearest row latitude from this table and assign the same row number.

Thus, with the above procedure, the path and row numbers and other details of the point of interest can be obtained. The details presented in Tables 4.2.2 to 4.2.5 are tentative and the full detailed information will be available in due course. However, the procedure to obtain the above details is the same.

4.2.13 FRAMING PROCEDURE AND SCENE CENTRE AND CORNER CO-ORDINATES EVALUATION FOR THE REFERENCING SCHEME

Based on the reference orbit, ephemeris are generated for all the 341 orbits of one coverage cycle. From the ephemeris, all the details about the paths over the Indian sub-continent are extracted.These details are path number, descending node details etc. Descending nodal points of all the paths are scene centres. The time taken by the satellite to traverse between any two consecutive scene centres of LISS-III is equal to 5703 lines multiplied by the

PATHS	50	55	60	65	70	51	56	61	66	71	52	57	62	67	72	53	58	63	68	73	54	59	64	69
	74	79	84	89	94	75	80	85	90	95	76	81	86	91	96	77	82	87	92	97	78	83	88	93
	98	103	108	113	118	99	104	109	114	119	100	105	110	115	120	101	106	111	116	121	102	107	112	117
	122	127	132	137	142	123	128	133	138	143	124	129	134	139	144	125	130	135	140	145				
Jan	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
	25	26	27	28	29	30	31																	
Feb								1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	18	19	20	21	22	23	24	25	26	27	28													
March												1	2	3	4	5	6	7	8	9	10	11	12	13
	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31						
April																			1	2	3	4	5	6
	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
May	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
	25	26	27	28	29	30	31																	
June								1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	18	19	20	21	22	23	24	25	26	27	28	29	30											
July														1	2	3	4	5	6	7	8	9	10	11
	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31				
Aug																					1	2	3	4
	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
	29	30	31																					
Sept				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
	22	23	24	25	26	27	28	29	30															
Oct										1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31								
Nov																	1	2	3	4	5	6	7	8
	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30		
Dec																							1	2
	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
	27	28	29	31																				

Table 4.2.2. Typical orbital calendar of IRS-1C

LATITUDE	ROW NO.	LONGITUDE	LATITUDE	ROW NO.	LONGITUDE
81.30	1	-88.78	42.79	39	-11.12
81.06	2	-81.05	41.61	40	-10.70
80.68	3	-73.82	40.43	41	-10.30
80.18	4	-67.23	39.25	42	-9.91
79.56	5	-61.34	38.07	43	-9.53
78.84	6	-56.15	36.89	44	-9.16
78.05	7	-51.58	35.71	45	-8.80
77.20	8	-47.59	34.53	46	-8.44
76.30	9	-44.08	33.34	47	-8.10
75.36	10	-41.00	32.16	48	-7.76
74.38	11	-38.29	30.97	49	-7.42
73.37	12	-35.87	29.79	50	-7.10
72.35	13	-33.72	28.60	51	-6.77
71.30	14	-31.79	27.41	52	-6.46
70.23	15	-30.05	26.22	53	-6.15
69.16	16	-28.48	25.04	54	-5.84
68.07	17	-27.04	23.85	55	-5.54
66.97	18	-25.73	22.66	56	-5.24
65.86	19	-24.53	21.47	57	-4.94
64.74	20	-23.41	20.28	58	-4.65
63.62	21	-22.38	19.09	59	-4.36
62.49	22	-21.42	17.89	60	-4.08
61.36	23	-20.53	16.70	61	-3.79
60.22	24	-19.69	15.51	62	-3.51
59.07	25	-18.90	14.32	63	-3.23
57.93	26	-18.16	13.13	64	-2.96
56.78	27	-17.45	11.93	65	-2.68
55.62	28	-16.79	10.74	66	-2.41
54.47	29	-16.16	9.55	67	-2.14
53.31	30	-15.55	8.35	68	-1.87
52.15	31	-14.98	7.16	69	-1.60
50.98	32	-14.43	5.97	70	-1.33
49.82	33	-13.90	4.77	71	-1.06
48.65	34	-13.39	3.58	72	-0.80
47.48	35	-12.91	2.39	73	-0.53
46.31	36	-12.43	1.19	74	-0.27
45.13	37	-11.98	0.00	75	0.00
43.96	38	-11.54			

Table 4.2.3 The difference in longitude of a given row latitude and decending time

Path	Longitude	Path	Longitude
65	37.866	101	75.872
66	38.922	102	76.928
67	39.977	103	77.983
68	41.033	104	79.039
69	42.089	105	80.095
70	43.145	106	81.150
71	44.200	107	82.206
72	45.256	108	83.262
73	46.312	109	84.318
74	47.367	110	85.373
75	48.423	111	86.429
76	49.479	112	87.485
77	50.535	113	88.540
78	51.590	114	89.596
79	52.646	115	90.652
80	53.702	116	91.708
81	54.757	117	92.763
82	55.813	118	93.819
83	56.869	119	94.875
84	57.925	120	95.930
85	58.980	121	96.986
86	60.036	122	98.042
87	61.092	123	99.098
88	62.148	124	100.153
89	63.203	125	101.209
90	64.259	126	102.265
91	65.315	127	103.321
92	66.370	128	104.376
93	67.426	129	105.432
94	68.482	130	106.488
95	69.538	131	107.543
96	70.593	132	108.599
97	71.649	133	109.655
98	72.705	134	110.711
99	73.760	135	111.766
100	74.816		

Table 4.2.4 Equatorial crossing longitude for various paths

Path	GMT	Path	GMT
65	7:59	101	5:27
66	7:54	102	5:22
67	7:50	103	5:18
68	7:46	104	5:14
69	7:42	105	5:10
70	7:37	106	5:05
71	7:33	107	5:01
72	7:29	108	4:57
73	7:25	109	4:53
74	7:21	110	4:49
75	7:16	111	4:44
76	7:12	112	4:40
77	7:08	113	4:36
78	7:04	114	4:32
79	6:59	115	4:27
80	6:55	116	4:23
81	6:51	117	4:19
82	6:47	118	4:15
83	6:43	119	4:11
84	6:38	120	4:06
85	6:34	121	4:02
86	6:30	122	3:58
87	6:26	123	3:54
88	6:21	124	3:49
89	6:17	125	3:45
90	6:13	126	3:41
91	6:09	127	3:37
92	6:05	128	3:32
93	6:00	129	3:28
94	5:56	130	3:24
95	5:52	131	3:20
96	5:48	132	3:16
97	5:43	133	3:11
98	5:39	134	3:07
99	5:35	135	3:03
100	5:31		

Table 4.2.5 Equatorial crossing time (GMT) for various paths (descending node)
(Local time at node 10:30 hrs.)

integration time, which is known. Therefore, all the details of LISS-III scenes along the paths are obtained taking descending nodal points as reference. While assigning the row numbers, counting is done from northern most scene centre on a path. The size of LISS-III scene is 6000 pixels X 6000 lines. Once scene centre time is known, by taking 3000 lines above and below that point the scene start and end timings can be obtained.

In this process, the along track overlap is automatically taken care and sidelap is given by ground track placings. Similarly, all the LISS-III scenes are sized along the track. By evaluating corner coordinates of each scene, the framing is completed. The details are provided in the next section.

Each LISS-III scene can contain four PAN scenes (Figure. 4.2.4). From the scene definitions, it is possible to obtain the start and end timings of PAN scenes by knowing the LISS III scene centre time. With respect to LISS-III scene centre, scene centres and corner points of other payloads in terms of lines and pixels can be established. Therefore, other payload scenes are easily framed. The layout of scenes are such that the requirements of overlap and sidelap are taken care of.

4.2.14 ESTIMATION OF THE CENTRE AND CORNER CO-ORDINATES OF LISS-III AND PAN SCENES

From the ephemeris information, it is possible to compute geographical coordinates of LISS-III scene centres which lie on the ground track. However, this is not the case with PAN scene centers as they lie on either side of the ground track. The time of occurrence of any PAN scene center or any corner coordinate is obtained by using the information that the scanning is line by line at an interval of integration time of the respective cameras. Taking LISS-III scene center as the origin, the coordinates of any point is established in terms of lines and pixels.

In figure 4.2.6, let a1 be a point on the ground track with coordinates (ϕ_1, λ_1).Let P be a corner point of a scene.

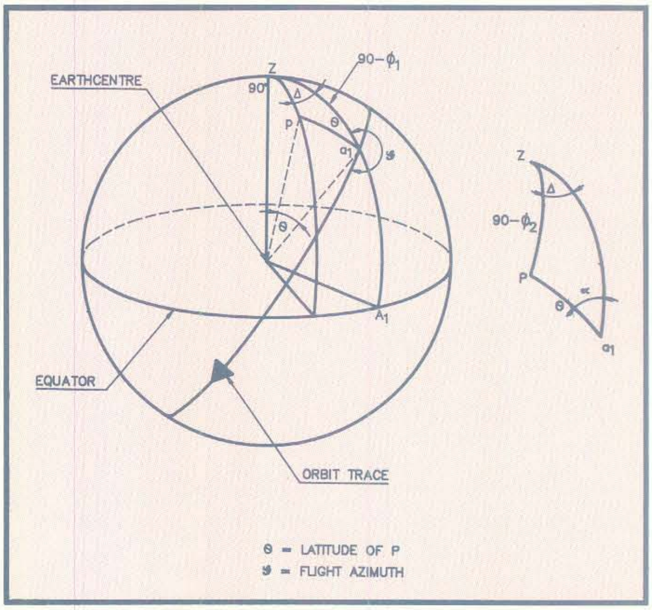


Figure 4.2.6 Calculations of coordinates of a point P on the earth surface

The coordinates of P, say, (ϕ_2, λ_2) can be calculated as follows.

$\text{Sin}\,\phi_2 = \text{Cos}\theta\ \text{Sin}\phi_2 \pm \text{Sin}\theta\ \text{Cos}\phi_1\ \text{Cos}\alpha$ - (1)

Where $\alpha = 2\pi - \zeta \pm \pi/2$
and θ, ϕ_1, ϕ_2 and ζ are the angles as shown in Figure 4.2.6

$\text{Cos}\,\theta = \text{Sin}\phi_1\ \text{Sin}\phi_2 \pm \text{Cos}\phi_1 \text{Cos}\phi_2\ \text{Cos}\Delta$ - (2)

Where Δ is longitudinal difference of λ_2 from λ_1
is the angle subtended by arc a1P (Fig. 4.2.6) at the centre of the Earth.

Using equation (2) the expression for 'Cos Δ ' can be derived as

$$\text{Cos}\Delta = \frac{\text{Cos}\,\theta - \text{Sin}\phi_1 \text{Sin}\phi}{\text{Cos}\phi_1\ \ \text{Cos}\phi_2} \qquad \text{(3)}$$

Appropriate sign is used to denote ' Δ ' depending on whether the point P (ϕ_2, λ_2) is east or west of point a_1 (ϕ_1, λ_1)

The longitude λ_2 is, therefore obtained as

$$\lambda_2 = \lambda_1 \pm \Delta \qquad (4)$$

Thus, the geographical co-ordinates of any required point can be obtained either for any corner or the centre of the scene.

4.2.15 DEVIATIONS OF ORBIT AND ATTITUDE PARAMETERS AND ITS EFFECT ON THE IMAGE

The referencing scheme has been generated for the reference orbit under ideal conditions.In practice, orbital parameters vary from the reference orbit due to perturbations. Similarly, due to internal and external torques acting on the satellite, its attitude slowly drifts. Both orbit and attitude parameters are controlled within certain limits by the attitude and orbit control system.

These perturbations cause the scenes to slightly deviate from the nominally predicted locations. It is therefore necessary for users to understand the deviations to see how best they can use the successive images of a specific scene, for registering, overlaying and for comparison . In this section, a brief summary of the image deviations is given.

Orbit Perturbations

In order to maintain the required coverage pattern and local time, it is essential that the defined sun-synchronous orbit be maintained throughout the operational life time of the satellite. Even after the launch vehicle injection errors are removed, the perturbations to the orbit, orbit determination and orbit adjust system uncertainties cause deviations from the ideal sun-synchronous orbit. Hence,orbital parameters have to be controlled near to the ideal orbit within the tolerance specified. The main perturbations are due to atmospheric drag, asphericity of the Earth and to some extent by lunisolar gravitational attraction. Deviations caused by these are corrected by periodic orbit adjust operations. The effect of the deviations within the limits of these corrections are discussed in subsequent sections.

Atmospheric Drag

Though the atmospheric density is small at an altitude of about 1000km, the same cannot be neglected, as it causes gradual loss of altitude continuously,if the same is not controlled. Due to altitude decay, the time period of the orbit changes which affects the ground track pattern and therefore coverage pattern. It is planned to control the ground track pattern to within ±5 Km. of the nominal pattern. This would be achieved by suitably controlling the altitude within corresponding limits. Periodicity of altitude corrections depends on the decay rate.

Asphericity of the Earth

Asphericity of the earth has two major effects, namely;

i. Circular orbit becomes eccentric and eccentricity varies in a sinusoidal fashion.
ii. Apsidal line, that is the line joining the perigee and apogee points in the orbit, rotates in the orbital plane. The period of this rotation for IRS orbit is estimated to be around 132 days. Due to the frozen orbit concept, to be adopted for IRS-1C, the perigee is almost maintained near the orbital pole and the mean eccentricity is maintained at 0.0010033.

Eccentricity leads to variations in altitude as well as velocity. Since the earth is geoid shaped, even for a pure circular orbit,satellite does not have same altitude throughout the orbit. The altitude variations cause scale variations of the image (Figure. 4.2.7) for a given camera system. Due to the frozen perigee,altitude variations over the Indian region would be within 10 Km.

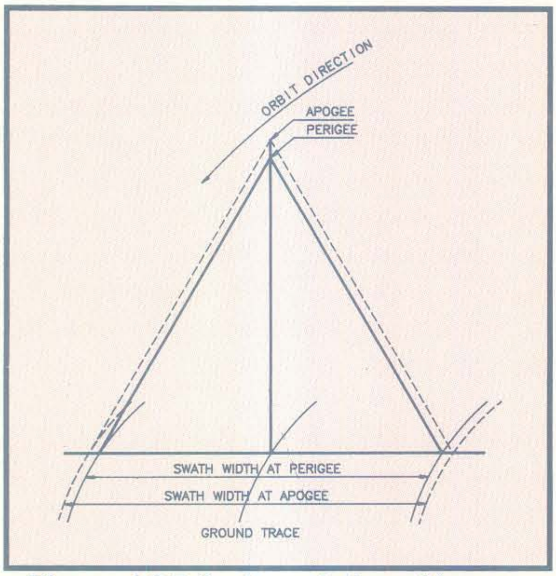


Figure 4.2.7 Scale variation of image with altitude

Equator is taken as the reference for framing the scenes while generating the referencing scheme. Equator is also being taken as reference during the actual operations and the descending node point is determined based on the current ephemeris. Hence, the along track error due to eccentricity is negligible at this point. Taking this point as reference, the other LISS-III scene centres are marked on a given path on the basis of 5703 lines between any two scene centres. Integration time for each line is fixed and therefore the time difference between any two scene centres along the path is also fixed.

<u>Luni-Solar Gravitational Attraction and Solar Radiation Pressure</u>

Additional perturbations to the orbit are examined here. This includes luni-solar gravitational attraction and solar radiation pressure. For IRS,the solar radiation pressure has negligible effects, whereas, luni-solar gravitational attraction causes specular variations of about 0.041 degree per year in inclination apart from periodic perturbations. Variations in the inclination affects ground track pattern as well as

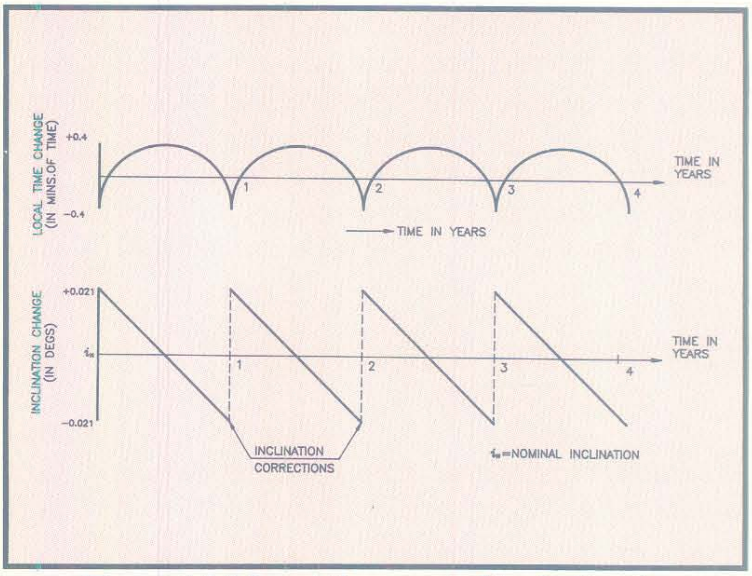


Figure 4.2.8 Local time control by inclination corrections

local time. Since the variations are secular, compensation can be done easily. The inclination is biased by .02 degree towards a favourable side,so that,it drifts to the nominal value after 6 months. Yearly corrections to inclination will be done to restrict its contribution to local time variation within ±0.4 minutes as shown in Figure.4.2.8.

4.2.16 ORBIT DETERMINATION AND PREDICTION ERRORS

It is rather difficult to model accurately all the perturbing forces to represent the true motion of the satellite. When orbit predictions are carried out,the trajectory deviates from the true trajectory and the deviation builds up continuously. Therefore,periodic orbit determinations would be carried out using tracking observations of the satellite (like range, range rate etc.,) Since,both dynamic model and observations are imperfect and there are many observations than the number of parameters to be determined, this is an over determined system and therefore orbit determination would be carried out using an estimation technique in the statistical sense. The positional accuracy of the definitive orbit would be around 400 meters(3 sigma) and after one day prediction,the positional accuracy will be around 1Km (3 sigma) for IRS. For browse products generation,one day predicted ephemeris and for standard products,definitive orbital ephemeris would be used. The image location accuracies in each of these products are affected by the accuracies cited above.

4.2.17 DEVIATIONS OF ATTITUDE PARAMETERS

To align the payload cameras along the nadir line, continuously, IRS has been configured for 3 axis stabilised mode of attitude which is achieved through a set of attitude sensors and control hardware. Controlling is necessary because of environmental and internal torques which affect the attitude stabilisation continuously. Due to the presence of various errors in attitude sensing and controlling, the attitude would be controlled upto 0.15degree in pitch and roll and 0.2 degree in yaw. The effect of pitch, roll and yaw on image is shown in Figure 4.2.9. The pitch error shifts the scene in the along track direction, whereas, roll error shifts the scene in the across-track direction. Due to yaw error, the scene is rotated through the same angle about the nominal scene centre.

The attitude determination accuracy is better than the controlling accuracy and would be ±0.07 degree in pitch and roll and ±0.1 degree in yaw. The

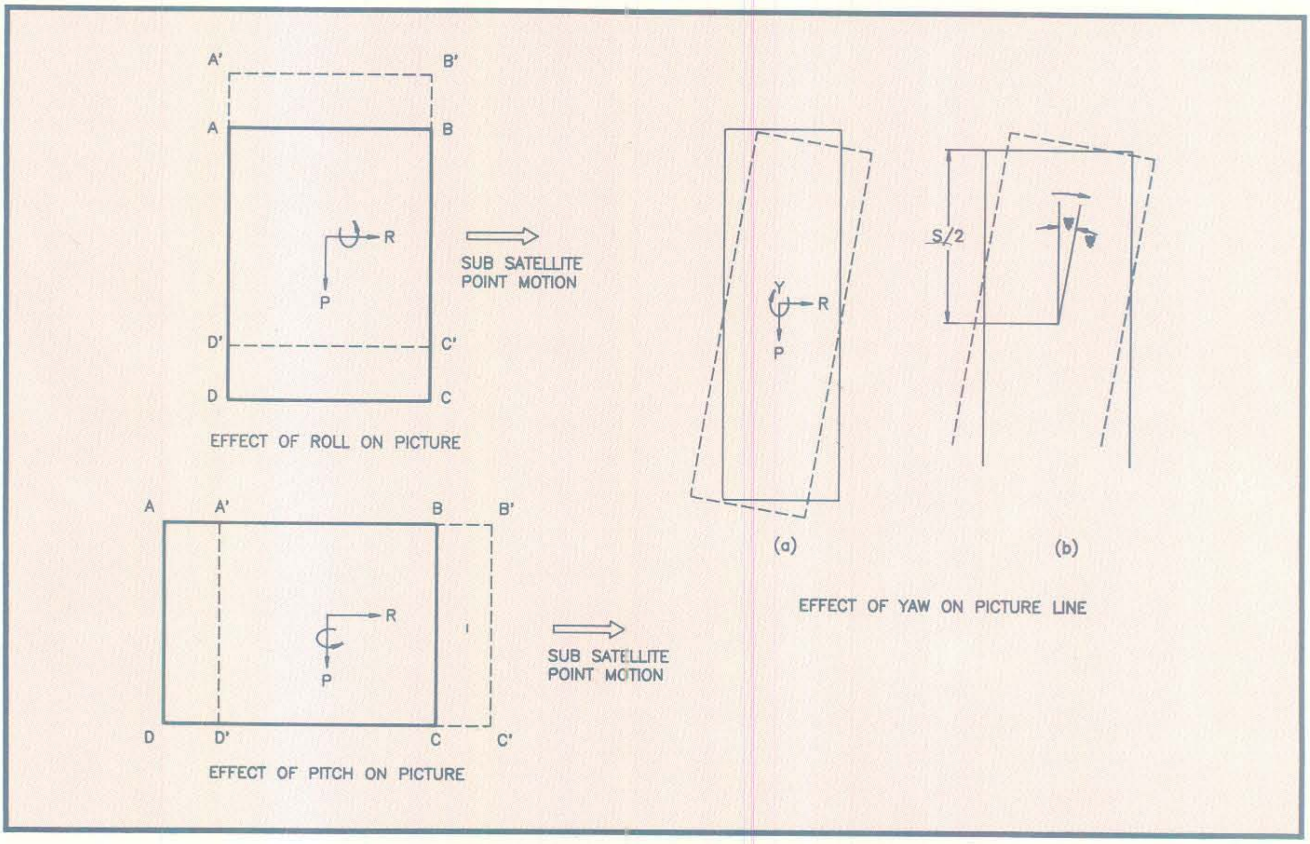


Figure 4.2.9 Effect of attitude errors on image

deviations of scenes from the nominal depends only on the controlling accuracies. Determined attitude information is used to correct the image and for annotation.

Across Track deviations Of the Image

Across track deviations of the image essentially depends on ground track pattern deviations, the accuracy of information on ground track, roll and yaw errors etc.,. Taking into account the uncertainties in orbit determination and orbit adjust system, the ground track pattern would becontrolled within ±5 Km. about the nominal pattern. It is clear that the above implies a reduction in effective window to account for orbit determination and orbit adjust system uncertainties. Roll error of 0.15 degree causes track deviations of about 2.1 Km and yaw error of 0.2 degree would cause 0.35 Km. under the worst case. The Root Sum Square (RSS) of all these deviations is about 5.4 Km.

Along Track deviations Of the Image

The along track deviations of the image are due to eccentricty, orbit determination/prediction accuracy, the shape of the earth, and attitude control accuracy. The eccentricity effect is considered to some extent by choosing the frozen orbit concept. Velocity variations due to eccentricity are considered in the referencing scheme itself. Pitch error of 0.15 degree would cause 2.1 Km. along track deviation at the worst case. The component of yaw error introduces 0.3 Km. One day predicted ephemeris are used for browse products which have positional information to the accuracy of about ±2 Km. With all these, the along track deviation is about 3 Km (RSS).

This deviation is reduced by following an appropriate framing procedure during actual operations. However, the across track deviation within ±5.4Km. cannot be reduced by any such procedures as it is a derivative of all the system components involved.

4.2.18 IMAGE FRAMING DURING ACTUAL OPERATIONS

In the earlier section, the deviations of the actual scenes with respect to nominal scenes have been described. For mosaic generation, user may have to use scenes obtained in different coverage cycles. With such large deviations, it was found that mosaic formation may be difficult, and also the user may have to order several scenes to get the required area information. During the process of evolvement, it was found that it is difficult to reduce the across track deviations, whereas, with an appropriate procedure for image framing, there is a possibility of reducing the along track deviations. Therefore, it was decided to adopt this method during actual operations. It may be noted, that, image deviation means the distance between the centre of the actual scene obtained and the centre of the corresponding scene defined in the path-row referencing scheme. This should be distinguished from the locational accuracy determined by the orbit and attitude information.

The following framing procedure is being adopted:

i. All the relevant row latitudes as defined in the referencing scheme should be stored.
ii. The same row latitudes for actual scenes also should be adopted. This is accomplished by interpolating the time for a given row latitude along the path.
iii. All the LISS-III scene centres along the path should be marked by following the above proce dure.

iv. The LISS-III scenes about the above scene centres should be constructed by taking 3000 lines above and below about these points along the path. The end and beginning of each LISS-III scene along the path should be marked.

v. WIFS and PAN scenes are then framed in and on LISS-III scenes, by adopting the same procedure, which is used, while generating the referencing scheme.

The main advantage of the above procedure is, that, major portion of along track deviation with respect to the nominal scenes get reduced. However, the distance between any two scene centres in terms of number of lines may not always be 5703 lines and also the overlap between scenes may not be 297 lines. There will be small variations in them. Thus, the final deviations are

along track ± 3.0 Km
across track ± 5.4 Km

4.2.19 IMPACT OF THE DEVIATIONS ON OVERLAP AND SIDELAP DURING OPERATIONAL LIFE TIME

While framing the images for the referencing scheme, adequate overlap (along track) and sidelap (across track), are provided to aid the users to form a mosaic for a particular area or complete Indian region. Within a coverage cycle of 24 days, the impact of deviations is negligible and if the quality of all the images are good, then, it is possible to create a mosaic. However, in actual practice, quality of all the images may not be good due to the presence of cloud or some other reasons. Therefore, it is necessary to take images of different coverage cycles to generate the mosaic. In ideal situations, overlap or sidelap between adjacent images will exist. However, in actual practice, the deviation mentioned in the earlier sections will affect sidelap/overlap between images of one cycle and corresponding images of any other cycle during the operational life time of the satellite. For example, a scene of cycle N1 corresponding to path and row of P1 and R1 has a prescribed amount of overlap with a scene of the same cycle corresponding to path and row of P1, R1 + 1. However, it may not have the same amount of overlap, due to deviations, with a scene of cycle N2 corresponding to path and row of P1, R1 + 1. Similar is the situation for sidelap.

Overlap or sidelap varies due to the deviations mentioned in the earlier section and due to scale variation of the image because of variation in the altitude. However, scale variation affects only sidelap but not overlap as scanning is accomplished line by line, along the track.

Overlap Variation

The nominal overlap provided between any two LISS-III scenes is 7 Km. which is equivalent to 297 lines. The maximum deviation (along the track) is of the order of 5Km. with the new framing procedure. Due to this, the distance between two scenes of different cycles will be different.

Sidelap Variation

Sidelap is the common area between two adjacent scenes of any two consecutive paths . However, sidelap between scenes of two consecutive paths of different cycles is affected by across track deviations and scale variations. The nominal sidelap increases from equator to northern latitudes. Due to this, deviation in sidelap happens at the equator. Therefore, the sidelap variation at equator is discussed here.The nominal sidelap at the equator would be 23.5 Km. for LISS-III scene. The across track deviation would be the order of ±5.4 Km near the equator for LISS-III scene. Therefore, the two adjacent scenes of different cycles can be near by or away by twice this amount.

4.2.20 ACCURACY OF ORBIT AND ATTITUDE PARAMETERS USED FOR GENERATING DATA PRODUCTS

In the earlier sections, the deviations and overlap/sidelap variations of the actual scenes from the nominal scenes were described. Since orbit and on LISS-III scenes, by adopting the same procedure, which is used, while generating the referencing scheme.

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across track ± 5.4 Km

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4.2.20 ACCURACY OF ORBIT AND ATTITUDE PARAMETERS USED FOR GENERATING DATA PRODUCTS

In the earlier sections, the deviations and overlap/ sidelap variations of the actual scenes from the nominal scenes were described. Since orbit and attitude determinations are carried out continuously, during the mission, the information about the actual scene (deviated from the reference scheme) are known to the best accuracies possible under operational environment. These information are used to generate browse, standard and other products. For browse products generation, one day predicted ephemeries with no attitude information are used, whereas, for standard products generation, definitive orbit and attitude parameters are used. Thus, any location in a scene of standard products can be identified within ± 2.2 Km. The accuracies of different products are presented here.

Browse Products

One day predicted ephemeris with no attitude information are used to generate these products. To provide one-day-predicted ephemeris, orbit determination will be carried out every day at mission control centre by appropriately slicing the tracking data. The determination accuracy will be of the order of 400meters, in position and that of one day predicted ephemeris of the order of ±1 Km. As definitive attitude information is not used for browse products, the scene shfiting due to attitude pointing inaccuracy will not be known. Therefore, pointing accuracy has to be considered while evaluating the accuracy of browse products. Pointing accuracy would be ± 0.15 degree in pitch and roll and ± 0.2 degree in yaw which would result in ± 2.1 Km. error in the location of a point.

Standard Products

Definitive orbit and attitude information are used for standard products generation. The determination accuracy is expected to be ±400 meters in position and attitude determination accuracy ±.07 degree in pitch and roll and ±0.1degree in yaw with Earth sensor and Gyro. Therefore, the overall accuracy of the standard products comes to ±1.5 Km. The data from Star sensor being flown on IRS-1C will be used to improve the accuracy of orbit and attitude determination. The determined attitude from Star sensor will be used for data products generation, since, accuracy is expected to be ± 0.01 deg. in all three angles (pitch, roll and yaw). With this, the overall accuracy of standard products is expected to be around 800 meters and the major contribution comes from positional accuracy of 400 meters.

4.3 DATA PRODUCTS

4.3.1. INTRODUCTION :

Data products from the various sensors of IRS-1C will be of two types:

- Standard
- Special

Standard products are generated after applying radiometric and geometric corrections. Special products are generated after further processing the Standard products by mosaicing / merging / extracting and enhancement of the data.

The raw data recorded at the earth station is corrected to various levels of processing at the Data Processing System (DPS). They are:

Level 0	Uncorrected(Raw data)
Level 1	Radiometrically corrected and Geometrically corrected only for earth rotation (Browse product)
Level 2	Both Radiometrically and Geometrically corrected (Standard product)
Level 3	Special processing like merging, enhancement etc., after Level 2 corrections (Special product)

Level 2 and Level 3 products will be supplied to users.

All Standard products can be supplied on either photographic or digital media. Black & White (B/W) and False Colour Composite (FCC) photographic products will be available in the form of films or paper prints.

Digital products will be supplied on various magnetic media that are currently popular, viz., Computer Compatible Tapes (CCT), Cartridges, Exabyte Cartridge and floppies.

4.3.2 CORRECTIONS APPLIED TO RAW DATA

Raw data suffers from both geometric and radiometric distortions which have to be corrected. The various corrections applied are as follows :

Radiometric Corrections

Radiometric distortions arising due to the following factors will be corrected :

i. Non-uniform response of the detectors
ii. Specific detector element failure
iii Data losses during communication or archival/retrieval
iv. Narrow dynamic range;
v. Image to image variations.

A radiometric correction Look-Up-Table (LUT) is prepared for normalising the responses of all detector elements with respect to a desired common response. The least saturation radiance value realised over the whole array after disregarding extreme behaviour of one or two detectors, if any, is used as the reference. The same value can be used for conversion of radiometrically corrected Digital Number (DN) values back to absolute units by the users of the Data Products . This can be done using the ground calibration data for all detectors.

The correction for major frame synchronization losses (scanline losses) will be done using appropriate average of the neighbouring pixel values. If data losses occur in more than two consecutive scanlines, they will be replaced by a line consisting of all dark (minimum DN value) pixels. The failed detector pixel values (if any), will be replaced with the average of the adjacent pixels on the same scanline.

Geometric Corrections

Geometric distortions arising due to the following reasons will be corrected :

i. Scene related
  - earth rotation effect
  - earth shape(geoid) induced distortions

ii. Sensor related
  - sensor focal plane detector geometry
  - alignment of optical axis with respect to spacecraft attitude reference
  - multi-band and multi-array misregistration
  - off-nadir pointing (for PAN) induced distortions

iii. Spacecraft related
  - image orientation with respect to spacecraft heading
  - altitude and velocity variations affecting image scale
  - attitude variations in roll, pitch and yaw directions

iv. Measurement / Calibration Errors
  - estimation of spacecraft state vectors
  - attitude and pointing angles measurement
  - attitude change rate measurements
  - calibration of various alignment angles involved
  - synchronization of onboard and ground recep tion times

v. Multi image mosaicing related
  - image to image variations in geometric distortion

vi. Map projection, boundary overlay and resampling options

vii. Geocoded correction - true North Rotation

Geometric corrections will use swath modelling which is a pass processing approach using a few Ground Control Points(GCP), to improve the orbit and attitude parameters.

Geometric corrections will be performed through a dynamic model, which represents the imaging geometry. Through this model, an image to ground mapping will be achieved, which is a function of payload parameters, satellite orientation, etc. This in turn consists of a series of transformations from one coordinate system to another.

A grid of input coordinates (scanline, pixel) on the radiometrically corrected image will be selected and the corresponding output coordinates(,) will be calculated for all the grid points. For an user area given in the output space, a grid will be defined and the input coordinates for these grid points will be obtained through interpolation from the earlier computed points. The input coordinates for the intermediate points of output space will be obtained by another interpolation, now in the output space only. The gray values for all the output points will be obtained by resampling the input image. Map projection and the image orientation (for geocoded products) are incorporated at the time of fixing the output grid. Finally, the data is formatted for generating the photographic or digital products in the required format.

The photographic annotation format of all standard and special products will be the same, but, the annotation format of District geocoded products and Zonal products will be different. For details regarding the annotation format for all the types of products refer to section 4.4.

4.3.3 STANDARD PRODUCTS

The various kinds of Standard products that will be supplied are as follows :

i. Path/Row products
ii. Shift Along Track products
iii. Quadrant products
iv. Stereo products
v. Geocoded products.

4.3.3.1. Path/Row Based Products

These products will be generated based on the referencing scheme of each sensor. The user has to specify the following.

i. Path/Row number as per Referencing Scheme
ii. Sensor Identification
iii. Subscene Identification (for PAN)
iv. Date of Pass
v. Band number for B/W and Digital products, Band combination for FCC products
vi. Product Code

System Inputs :

i. Video data and (i) line count (ii) ground reception time and altitude change rates for LISS-III/PAN scanline
ii. Ancillary data in Disk files
iii. Radiometric calibration LUT file
iv. Mission specific constants from Parameter file
v. Job identification code (specifying request id, product sequence number)
vi. Product priority.

The SWIR band of LISS-III has a different resolution, hence, photo products will be made available in both visible and SWIR resolutions.

4.3.3.2. Shift Along Track Products

If a user's area of interest is less than the dimensions of a full scene and falls in two successive rows of the same path, then the data will be supplied by sliding the scene in the forward (along the path) direction. These are called Shift Along Track (SAT) products. This way, the required area can be accomodated in a single product.

In the case of SAT products ,the percentage of shift has to be specified in addition to the inputs specified by the user for Path/Row based products. The percentage of shift along the path has to be specified between 10 % to 90 % in multiples of 10%. Figure 4.3.1 depicts the concept of a scene which has been shifted along track.

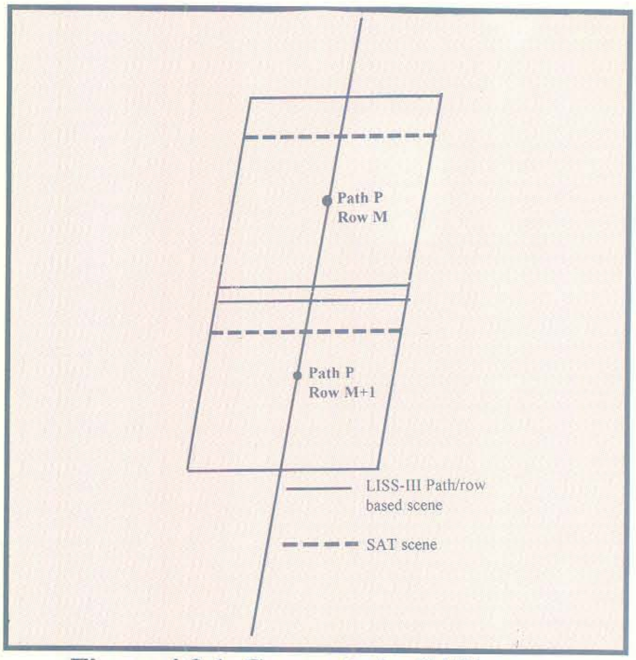


Figure 4.3.1. Concept of a SAT scene

4.3.3.3. Quadrant Products

Each LISS-III scene is divided into four nominal and twelve derived quadrants (Figure 4.3.2). As seen

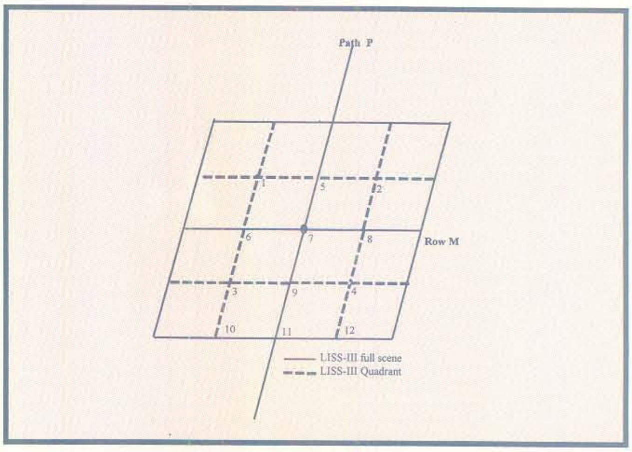


Figure 4.3.2. LISS-III quadrants

from the Figure, Quadrant numbers 1,2,3,4 are nominal quadrants. The remaining eight quadrants are obtained after sliding quadrants 1, 2, 3 and 4 by 25%, along and across the scene, within the path, in the forward direction. LISS-III quadrant products are generated on 1:125,000 scale.

The advantage of LISS-III quadrant,is the availability of photographic product on a higher scale i.e. 1:125,000 and also because it can be compared with IRS1A/1B LISS-II products of the same scale for temporal /change detection studies.

Quadrant products will be supplied from the LISS-III sensor in the visible band resolution, for visible and near near infra-red bands only. Quadrant products will not be available in SWIR band resolution. While placing a request for these products, the users need to specify the quadrant number, in addition to the details specified in the case of Path/Row based products.

4.3.3.4. Stereo Products

The oblique viewing capabilty of PAN sensor can be used to acquire stereopairs. A stereopair comprises of two images of the same area acquired on different dates and at different angles.

One of the parameters from which the quality of a stereopair can be judged is the Base/Height (B/H) ratio.B/H ratio is the ratio of the distance between two satellite passes and the satellite altitude (Figure 4.3.3).

Stereo products will be available from the PAN sensor only. The input required in addition to Path/Row details is B/H ratio. Two scenes selected on two different dates satsifying the user's B/H ratio will be supplied as a stereo pair. These will be available as B/W photographic and digital products. Photographic products will be available on 1:250,000 scale.

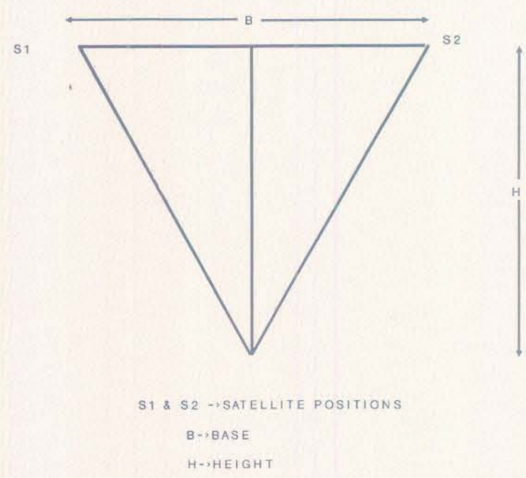


Figure 4.3.3 Concept of stereopairs

Stereo products will be supplied with two levels of processing :

i. Only Radiometrically corrected
ii. Radiometrically corrected and Geometrically corrected for Across Track correction.

The above two levels of processing will be available with or without Histogram Equalisation.

Stereopairs are widely used in photo interpretation for releif perception and also in photogrammetric studies for deriving DTM models.

Stereo Triplet products will also supplied. Here, in addition to the two scenes forming the stereo pair, a nadir pointing scene is also supplied.

4.3.3.5.Geocoded Products

Geocoding corrects the imagery to a source independent format whereby multidate and multisatellite data can be handled with ease. Geocoded products are generated after applying radiometric and geometric corrections,orienting the image to true north and generating the products with an output resolution appropriate to the mapscale. The advantage of a geocoded product is that it can be overlaid on a Survey of India (SOI) toposheet map.

Geocoded products will be generated based upon the SOI mapsheets, for PAN on 1:25,000 scale and for LISS-III on 1:50,000 scale in both SWIR and Visible band resolutions. The inputs required to be specified by the user in addition to those provided in case of Path/Row based products, is the SOI Mapsheet number. Table 4.3.1 gives the details of geocoded products.

In case of IRS-1A/1B, if a geocoded mapsheet falls in between two path/subscenes,the same is being supplied as two products.However, this problem will be overcome during the IRS-1C time frame. All geocoded products from LISS-III sensor will be supplied as a single product after mosaicing, even if the mapsheet lies inbetween two paths. A cloud free mosaic will be made using data of adjacent paths with a time separation of

(i) 5 days
(ii) one cycle
(iii) several cycles but within the same season
(iv) same season of the previous year.

This will be done to achieve the best possible radiometric quality.

In the case of PAN, when a 7 1/2' x 7 1/2' mapsheet falls in more than one subscene, a mosaic is made. In case, the mapsheet falls in between two paths, no mosaic will be made, instead, it will be supplied with zero fills. The scales of the LISS-III and PAN geocoded master films are 1:250,000 and 1:125,000 respectively. By enlarging the film 5 times photographically, 1:50,000 and 1:25,000 scale products

Product Type	Area	Output Resolution	Scale
Mapsheet based products			
LISS-III geocoded products in visible band resolution (B/W and FCC)	15'x15'	12.5	1:50,000
LISS-III Geocoded products in SWIR band resolution (B/W and FCC)	15'x15'	25	1:50,000
PAN Geocoded products	7.5'x7.5'	6.25	1:25,000
Special Geocoded Products			
User specified PAN geocoded products	5'x5'	3.125	1:12,500
District geocoded products			
Categories A,B,C		25	1:250,000
Category D		50	1:500,00

Table 4.3.1 Details of geocoded products

for LISS-III and PAN respectively, will be generated. In order to account for the location inaccuracy, extra area corresponding to 2 1/2' will be provided in LISS-III geocoded product and 1/2' extra area in case of PAN geocoded products. In total, a LISS-III geocoded product covers an area of 17 1/2' x 17 1/2' and a PAN geocoded product will cover an area of 8' x 8'. The location accuracy of geocoded products will be the same as that of Standard products.

4.3.4. SPECIAL PRODUCTS

Special products are generated after further processing standard products by extracting a specific area, mosaicing, merging and enhancing the data. The various types of special products that will be supplied are as follows :

i. LISS-III District Geocoded products
ii. PAN 5'. x 5' Geocoded products
iii. PAN Full scene (Path/Row Based and SAT)
iv. PAN Quadrant products (PAN I or PAN Q)
v. Orthoimage
vi. PAN + LISS-III Merged products
vii. WiFS Zonal products
viii. WiFS - VIM Zonal products
ix. WiFS - VIM Full India products

4.3.4.1. LISS-III District Geocoded Products

This product will be generated by mosaicing the standard corrected LISS-III scenes covering the district. The mosaic will then be rotated to true north.

The inputs to be specified by the user are as follows

- State/Union Territory's name and district name as prevalent in the year 1991.
- All inputs as specified for Path-Row based products.

The criteria that will be used while selecting the scenes for preparing the mosaic is the same as in the case of LISS-III mapsheet based geocoded products. Depending on the areal extents, the districts in India have been classified into four categories :

Category	Area (Km x Km)
Class A	45 x 45
Class B	90 x 90
Class C	180 x 180
Class D	400 x 400

Geocoded products of districts falling in Categories A, B and C will be supplied in 1:250,000 scale, while those of category D will be supplied in 1:500,000 scale. The physical size of photographic products will be 480 mm for A and B categories and 960 mm for C and D categories.

4.3.4.2. PAN 5' x 5' Geocoded Products

Area corresponding to 5' x 5' within a path will be extracted around a user specified point and aligned to true North after applying standard corrections. The inputs to be specified by the user are latitude/longitude of the point around which the 5' x 5' data is required, in addition to the details as in the case of Path/Row based products.

The main advantage of this product over the geocoded products is that it will be on a higher scale and can be overlaid on a 1:12,500 scale map.

4.3.4.3. PAN Full Scene (Path/Row) Products

PAN Full scene products will be generated by mosaicing the data collected by the three arrays. The correction level of these products is the same as that of standard products. The inputs to be specified are path, row and A, B, C or D. The master will be a 960 mm film and will be written on Large Format Photowrite System on 1:125,000 scale. The final product will be a 960 mm paper print on the same scale.

4.3.4.4. PAN Full Scene (SAT) Products

These products are PAN Full scene products but shifted along the track by the user specified percent. The percentage of shift varies between 10 % and 90% in the forward direction. The inputs to be specified by the user are same as those of PAN Full scene products. The scale of the 960mm master film is 1:125,000 scale and the final product will be supplied as 960 mm paper print.

4.3.4.5. PAN Quadrant Products

The PAN full scene is divided into four quadrants as shown in Figure 4.3.4. Here each quadrant corresponds to one and half a array data. Here again, the scale of the 960mm master film will be 1:125,000. The products will also be supplied on 960 mm paper print on 1:125,000 scale.

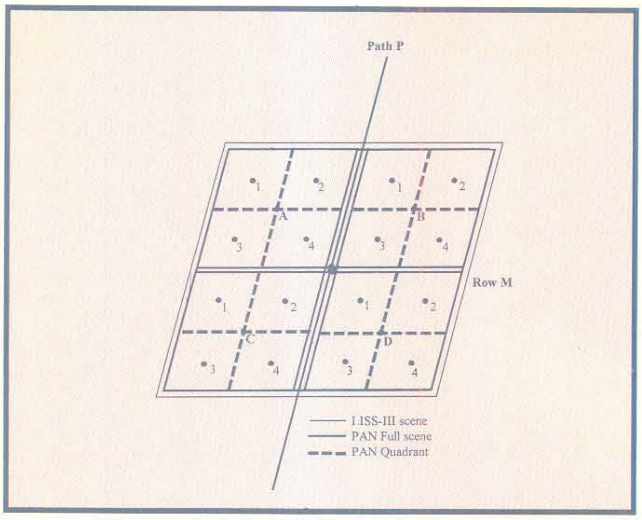


Figure 4.3.4 PAN quadrant scenes

4.3.4.6. PAN + LISS-III Merged Products

In order to exploit the dual advantage of the spectral resolution of LISS-III and the spatial resolution of PAN, it is planned to supply PAN+LISS-III merged products in PAN resolution. .The inputs to be specified by the user are as follows :

- Path and Row number as per referencing scheme
- Subscene ID for PAN
- Date of pass for PAN & LISS-III
- Product code

The criteria that will be considered while selecting the PAN and LISS-III scenes are:

i. PAN tilt is near nadir and the scene fits into a LISS-III scene.
ii. Day of pass is not separated by more than a few days.

These products will supplied on 1:25,000 scale as colour photographic products. Black and White and digital products are not supplied.

4.3.4.7. WiFS - Zonal Products

These products will be generated zone wise (Refer Figure 4.3.5 and Table 4.3.2). India is divided into 10 zones and each zone covers atleast one state completely. The inputs to be specified by the user in addition to path/row details, is the zone number. Based upon this input, the WIFS scenes covering the zone will be mosaiced and final product on 1:2 million scale will be generated on a 960 mm paper print. These products are supplied as Black and White products and digital products. The criteria considered while mosaicing the WiFS scenes covering the zone are as follows :

- Same cycle
- Adjacent cycles
- Same season of the previous year

4.3.4.8. WiFS - VIM Full India Products

The WiFS Vegetation Index Map (VIM) for full India will be generated by mosaicing the WiFS scenes covering the entire country within an interval of 10 days using the WiFS sensor. Vegetation Index is calculated using the IR and visible band data as follows

$$NDVI = \frac{(B2-B1)}{(B2+B1)}$$

where B1 is the visible band and B2 is the IR band.

The NDVI thus calculated results in real values ranging from (-1,1), a post normalisation is incorporated in this formula which results in the output range of (0,255).

The final product has been colour coded to 12 classes for interpretation and will be on 1:6 Million scale on 960 mm paper print. The inputs to be specified by the user is the specific date for which he would like to have the VIM Full India product and the other inputs as mentioned in the case of standard path/row products.

4.3.4.9 WiFS - VIM Zonal Products

As in the case of WiFS zonal products, the user has to specify the zone number and the other inputs similar to path/row based products. The scenes covering the zone are mosaiced and VIM product will be generated for the same. The criteria to be considered while selecting the scenes are as follows

- Same cycle
- Adjacent cycles
- Same season of the previous year

The final product will be supplied on 1.2 Million scale on 960 mm paper prints.

4.3.4.10. Orthoimage

It is planned to introduce Pan Orthoimages after a few months of IRS-1C launch. This is a new product and its generaion will be in an experimental phase before reaching operational status.

Zone No.	States Covered
1.	Jammu and Kashmir, Punjab, Himachal Pradesh, Haryana, Delhi, Parts of Uttar Pradesh and Rajathan
2.	Rajasthan, Gujarat and Haryana, Parts of Madhya Pradesh and Maharastra
3.	Uttar Pradesh, Parts of Bihar and Maharastra
4.	Assam, Arunachal Pradesh, Meghalaya, Manipur, Mizoram, Nagaland, Sikkim, Tripura and West Bengal
5.	Madhya Pradesh, Parts of Maharastra, Uttar Pradesh, Andhra Pradesh and Orissa
6.	Orissa, Bihar, West Bengal, Sikkim, Parts of Madhya Pradesh and Uttar Pradesh
7.	Karnataka, Tamil Nadu, Goa, Kerala, Lakhshadweep and Parts of Andhra Pradesh
8.	Maharastra, Parts of Karnataka, Andhra Pradesh, Tamil Nadu and Madhya Pradesh
9.	Andhra Pradesh, Parts of Karnataka, Madhya Pradesh, Maharastra, Tamil Nadu and Orissa
10.	Andaman and Nicobar Islands

Table 4.3.2 WiFS zones

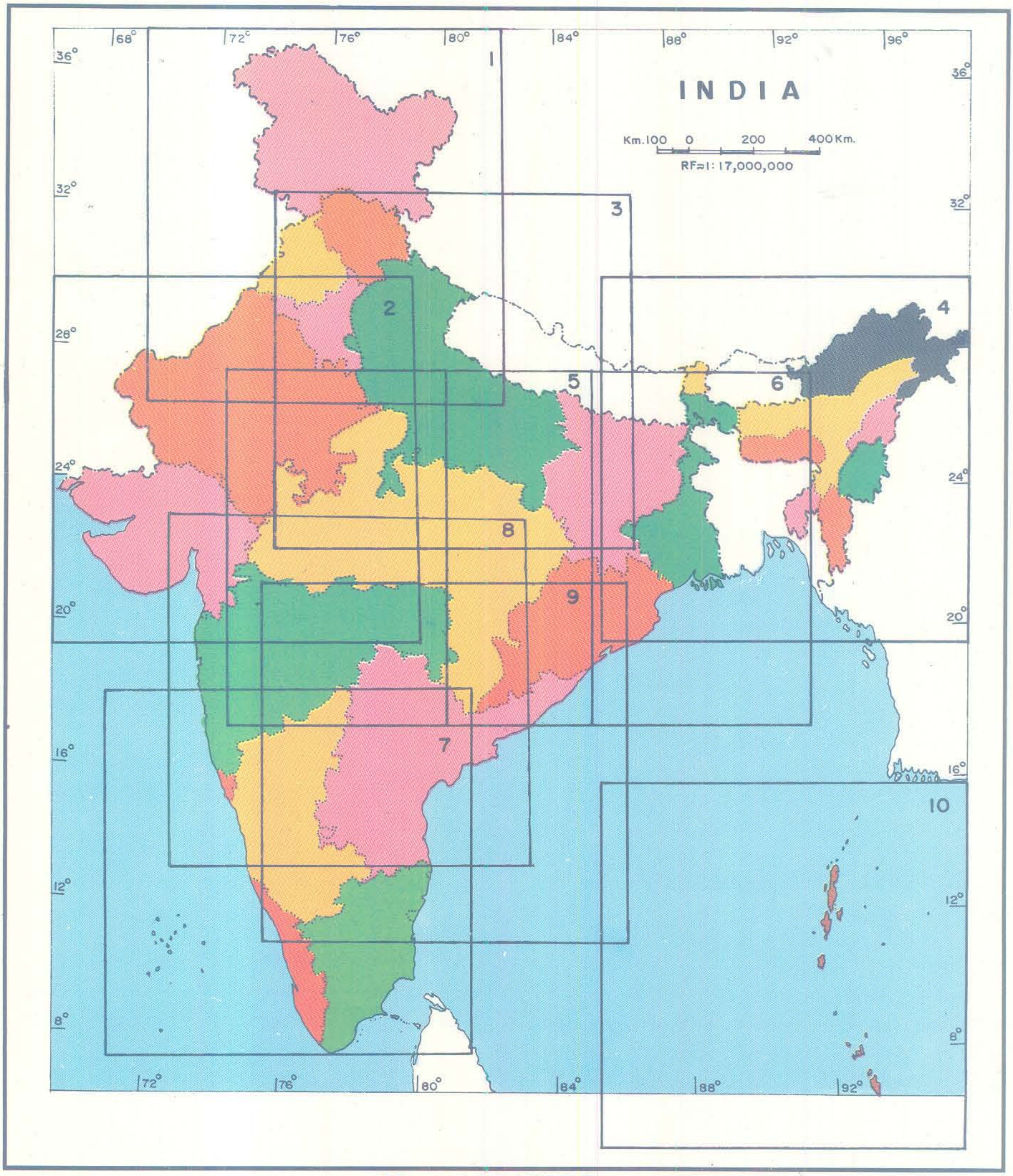


Figure 4.3.5 WiFS Zones

4.4 PHOTOGRAPHIC PRODUCTS

As mentioned in the earlier section, all photographic products will be available as:

B/W and FCC films
Paper prints

Masters of most of the photographic products will be 240mm films. For some of the Special products, the master will be a 960mm film. The 960mm master films are generated on a Large Format Film Recorder (LFFR) for products like PAN Quadrant, PAN Full scene etc.,.

In this section, we will be discussing the image annotation of each of the photoproducts. It is very essential to know the annotation format of every product since it gives all the information about the scene.

There will be two annotation formats as given below:

Annotation Format I

Applicable for all Standard and Special products except VIM/WiFS Zonal and LISS-III District Geocoded products.

Annotation Format II

Applicable for LISS-III District Geocoded and VIM/WiFS Zonal products.

Annotation format of IRS-1C photoproducts is different from that of IRS1A/1B. The geocoded products annotation format will be the same as that of the standard products, since, in the IRS-1C time frame, all geocoded products will be supplied as a single product after mosaicing and the details of the two scenes which are mosaiced will be mentioned in annotation line 2 (TOP) and annotation line 3 (TOP).

Annotation Format - I:

This annotation format has three lines on the top of the image data and one annotation line at the bottom of the data (Figure 4.4.1).

The first annotation line 1 on the top gives details regarding the satellite, the type of product i.e., if the scene is fixed or shift along track , details of area covered i.e. Full/Quad/Geo/India,indication if the data is OBTR data,band numbers,Gain settings,details about the product if it is Path based and with information on the resolution in case of MIR resolution products (the other options being Steropair(1/2)/ Stereotriplet(1/3)/ Merged/ Orthoimage/ VIM/ point based/ Mapsheet number),details regarding the projection i.e. POL(other options being SOM/LCC) and the resampling technique used i.e. CC/NN.

The second annotation line 2 on the top gives details regarding the date of acquisition with time, Path/Row details, sensor, subscene details, Quadrant number (the other option being percentage of shift), look angle information, the corrected scene centre and information on the Sun Elevation and Azimuth in degrees.

The third annotation line 3 on the top is repeated with the information content,same as that of annotation line 2 (top),if the generation of the data involves more than one scene.

The fourth annotation line 4 (bottom) at the bottom of the image data gives deatils regarding the Generation-ID, date of generation with time,the type of enhancement used i.e. HLUT/ CLUT/ EQLUT, details about which DPS generated the product i.e. DPS-1/ DPS-2/ DPS-3,place of generation, details regarding the DPSUSAGE and the information about the product generation agency. This annotation line is for internal use only.

Annotation Format - II

This format as mentioned earlier, is applicable only in the case of LISS III District geocoded products, WiFS/VIM Zonal products, since, in these products a minimum of three scenes are required to generate the final product. The annotation format for these products is given in Figure 4.4.2.

Annotation line 1 (top) gives information on the Satellite-ID,type of the product, details if the scene is fixed, information if the scene is a Full scene or a Zonal product,details if data is OBTR recorded,information if the product is a VIM or District geocoded product, details on the Zonal number in case of VIM or WiFS Zone or the name of the district in the case of LISS III District geocoded,details on the projection and the resampling technique used i.e CC/NN.

Annotation line 2 (top) and Annotation line 3 (top) gives details on the scene number,acquisition date,Path/Row details and the sensor information.

The fourth Annotation line 4 (Bottom) at the bottom of the image data gives details regarding the Generation-ID,date of generation with time,the type of enhancement used i.e.HLUT/ CLUT/ EQLUT, deatils about which DPS generated the product i.e. DPS-1/ DPS-2/ DPS-3,place of generation, details regarding the DPSUSAGE and the information about the product generation agency. This annotation line is for internal use only.

For details regarding user inputs to be specified,scale,area covered etc., for photographic products, refer Table 4.4.1 and Table 4.4.2.

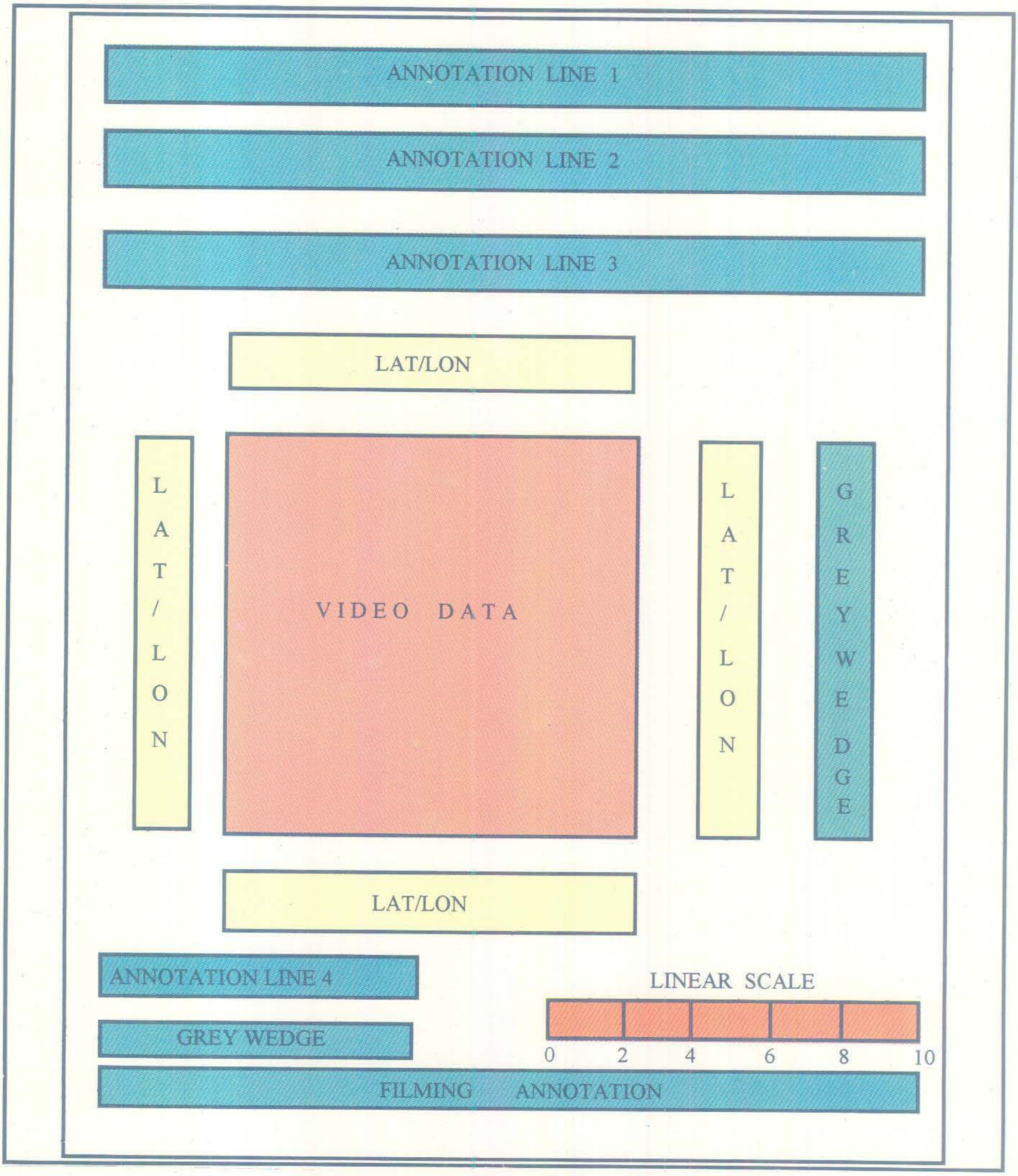


Figure 4.4.1 Photographic products layout

ANNOTATION LINE NUMBER 1 (TOP)

`IRS-1C STD FIXED FULL OBTR BANDS GAINS PATHBASED RESOL MIR POL CC`

A B C D E F G H I J K

CODES:

A	SATELLITE_ID
B	PRODUCT TYPE (OTHER OPTIONS ARE GEOCODED/MERGED/STEREO/VIM)
C	OTHER OPTION IS FLOAT
D	OTHER OPTIONS ARE QUAD/INDIA/GEO
E	THIS SPACE WILL BE LEFT BLANK IF THE PRODUCT IS NOT A OBTR PRODUCT
F	BAND NUMBER DETAILS, WILL BE BLANK IN CASE OF PAN PRODUCT
G	GAIN SETTINGS
H	OTHER OPTIONS ARE STEREOPAIR(1/2)/STEREOTRIPLET(1/3)/MERGED/ORTHOIMAGE/VIM/POINT BASED/MAPSHEET NUMBER
I	THIS WILL BE LEFT BLANK. IN CASE PRODUCTS ARE SUPPLIED IN VISIBLE RESOLUTION
J	TYPE OF PROJECTION (OTHER OPTIONS ARE SOM/UTM/PS/LCC)
K	TYPE OF RESAMPLING

ANNOTATION LINE 2 NUMBER (TOP)

`10APR96/10:30:10 P102/R025 L3 A0 QU:12 LA+15:30 FN:25-30-10/E72:30:45 E:90-A14`

A B C D E F G H

CODES:

A	DATE OF ACQUISITION WITH TIME
B	PATH-ROW DETAILS
C	SENSOR DETAILS (OTHER OPTION IS 'PN' FOR PAN AND 'WI' FOR WiFS)
D	SUBSCENE DETAILS (APPLICABLE IN CASE OF PAN PRODUCTS)
E	QUADRANT NUMBER (OTHER OPTION IS PERCENTAGE OF SHIFT)
F	LOOK ANGLE IN DEGREES
G	CORRECTED SCENE CENTRE LAT/LONG COORDINATES(Deg-Min-Sec)
H	SUN ELEVATION AND AZIMUTH (Deg.)

ANNOTATION LINE NUMBER 4 (BOTTOM)

`XT:12345 PROC ON:31-MAY-1996/22:40:10 NOLUT DPS-I HYDERABAD DPSUSAGE ISRO/NRSA`

A B C D E F G

CODES:

A	GENERATION _ID
B	DATE OF GENERATION
C	ENHANCEMENT(OTHER OPTION ARE CLUT/HLUT/EQLUT)
D	DPS AT WHICH THE PRODUCT WAS GENERATED
E	PLACE OF GENERATION
F	DPSUSAGE,THIS IS FOR INTERNAL PURPOSE ONLY
G	DATA GENERATION AGENCY

* ANNOTATION LINE NUMBER 2 (TOP) WILL BE REPEATED AS ANNOTATION LINE NUMBER 3 (TOP), IN CASE THERE IS MORE THAN ONE SCENE

Figure 4.4.2 Annotation Format - I

ANNOTATION LINE NUMBER 1 (TOP)

IRS1C	SPL	FIXED	FULL	OBTR	BANDS	GAINS	DIST	NAME OF THE DISTRICT	POL	CC
A	B	C	D	E	F	G	H	I	J	K

CODES:

- A SATELLITE_ID
- B TYPE OF THE PRODUCT
- C TYPE OF THE SCENE
- D SIZE OF THE SCENE
- E THIS SPACE WILL BE LEFT BLANK,IN CASE THIS IS NOT OBTR RECORDED
- F BAND NUMBERS
- G GAIN SETTING DETAILS
- H OTHER OPTION IS VIM
- I NAME OF THE DISTRICT
- J PROJECTION USED
- K RESAMPLING USED

ANNOTATION LINE NUMBER 2 (TOP)

SCENE 1	ACQ:11-APR-1996	P110/R056	LISS-3	SCENE 2	ACQ:06-APR-1996	P111/R056
A	B	C	D	E	F	G

CODES:

- A SCENE NUMBER
- B DATE OF ACQUISITION
- C PATH/ROW NUMBER (Pppp-Rrrr)
- D SENSOR DETAILS
- E SCENE NUMBER
- F DATE OF ACQUISITION
- G PATH/ROW NUMBER (Pppp-Rrrr)

ANNOTATION LINE NUMBER 4 (BOTTOM)

XT 12345	PROC ON 31-MAY-1996/22 40:10	NOLUT	DPS-I	HYDERABAD	DPSUSAGE	ISRO/NRSA
A	B	C	D	E	F	G

CODES:

- A GENERATION_ID
- B DATE OF GENERATION
- C ENHANCEMENT(OTHER OPTION ARE CLUT/HLUT/EQLUT)
- D DPS AT WHICH THE PRODUCT WAS GENERATED
- E PLACE OF GENERATION
- F DPSUSAGE,THIS IS FOR INTERNAL PURPOSE ONLY
- G DATA GENERATION AGENCY

*ANNOTATION LINE NUMBER 2 (TOP) WILL BE REPEATED AS ANNOTATION LINE NUMBER 3(TOP) WITH THE SAME DETAILS,IN CASE TWO OR MORE SCENES ARE INVOLVED

Figure 4.4.3 Annotation Format - II

Table 4.4.1. Standard photographic products

User input	Sensor	Area covered (Km x Km)	Photoproduct scale	Remarks
PATH/ROW Based B/W & FCC Products in visible & SWIR Resolution				
Path/Row	LISS-III (full scene)	141x141 B234 (Visible) 148x141 (SWIR) applicable in case of B/W products	1:1,000,000 1:500,000 1:250,000	B/W & FCC Available in SWIR and visible band resolutions
Path/Row	PAN (sub scene)	23.9x23.9 Nadir 30.5 x 23.9 (off nadir)	1:250,000 1:125,000 1:50,000	Only B/W products
Path/Row	WiFS (full scene)	810 x 810	1:6,000,000 1:2,000,000	Only B/W products
SHIFT ALONG TRACK PRODUCTS				
Path/Row & % of shift to nominal P/R % of shift in increments of 10%	LISS-III (full scene)	141x141 B234 (Visible) 148x141(SWIR) applicable in case of B/W products	1:1,000,000 1:500,000 1:250,000	B/W&FCC Available in SWIR and visible band resolutions
Path/Row & % of shift to nominal P/R	PAN (sub scene)	23.9x23.9 Nadir 30.5 x 30.5 (off nadir)	1:250,000 1:125,000 1:50,000	B/W products

Table 4.4.1 Standard photographic products (continued)

User input	Sensor	Area covered (Km x Km)	Photoproduct scale	Remarks
Path/Row & % of shift to nominal P/R	WiFS (full scene)	810 x 810	1:6,000,000 1:2,000,000	Only B/W products
QUADRANT PRODUCTS				
Path/Row along with quadrant no.	LISS-III	72x72	1:500,000 1:250,000 1:125,000	Not available in SWIR band resolution
STEREO PRODUCTS				
Path/Row, subscene & B/H ratio	PAN (sub scene)	23.9x23.9 (Nadir) 30.5x30.5 (off Nadir)	1:250,000	Products available with 2 levels of processing and with/without Histogram Equalisation (1) only radiometric (2) Radiometrically corrected & partially corrected Geometrically for Across Track correction.

Type	User input	Sensor	Area covered (Km x Km)	Photoproduct scale	Remarks
District geocoded	District name	LISS III	45x45 90x90 180x180 400x400	1:250,000 1:250,000 1:250,000 1:500,000	B/W & FCC products
PAN 5'x5 data	lat/long of the centre of users' area of interest	PAN		1:12,500	Only B/W products
PAN Full scene	Path/Row or Path/Row with%of shift	PAN	70x70 (Nadir) 90x70Km (off nadir)	1:125,000	
PAN Quadrant	PAN quadrant no. alongwith Path/Row	PAN	36x36(Nadir) 46x36 (off-nadir)	1:125,000	Only B/W products
Orthoimage	Path/Row alongwith B/H ratio	PAN	17x17	1:50,000	Only B/W products
PAN+ LISS-III merged products	Path/Row of PAN and LISS-III	PAN+ LISS-III	23.9x23.9	1:25,000	Only FCC products are available. No B/W and Digital products
WiFS Zonal	zone no.	WiFS	1150x1150	1:2,000,000	Only B/W products
VIM Full India	specific date	WiFS	3500x3500	1:6,000,000	Only FCC products
VIM Zonal Products	zone no.	WiFS	1150x1150	1:2,000,000	Only FCC products

Table 4.4.2 Special photographic products

4.5 DIGITAL DATA PRODUCTS

4.5.1 COMPUTER COMPATIBLE TAPES

4.5.1.1 Introduction

The data for all the sensors of IRS-1C will be supplied on digital media like Computer Compatible Tapes (CCTs), Cartridges, Exabyte tapes and Floppies on the basis of user request .Digital data is supplied with various levels of processing i.e. raw, browse, standard and special products. The file formats and structures in User CCT (UCCT) are the same for all levels of processing. The two formats in which digital data is supplied on CCTs, archived cartridges and Exabyte tapes are - Fast format and LGSOWG Super structure format. All digital data in super structure format will be provided in BIL/BSQ modes. However, in Fast format, data will be supplied in BSQ format only.

4.5.1.2 Fast Format

In Fast Format, in addition to the video data i. e. image data, one header information file will be provided. There are two files in the UCCT for Fast Format, the files are as follows :

Header file

This is the first file on each volume and contains header data in ASCII format. It will contain map projection, resampling options and tick marks.

Image file

All image files contain only video data. There will not be any prefix and suffix data with the individual image record.

4.5.1.3 LGSOWG Format

In LGSOWG format, in addition to the video data for a scene, each product will contain scene identification, location information, sensor, platform and processing related information. In the LGSOWG format, there are 5 files namely :

* Volume directory file
* Leader file
* Image data file
* Trailer file
* Null Volume file

Structure of files and records are given in Table 4.5.1.

Logical volume

A logical volume is a logical collection of one or more files recorded consecutively. A logical volume contains one or more band data of a scene.

All logical volumes have a volume directory as a first file and are concluded with a null volume directory. When a logical volume is split between physical volumes, the volume directory is repeated in the continuation tape. All logical volumes conclude with a null volume directory.

Volume Directory

The volume directory file is the first file of every logical volume. It is composed of volume descriptor record, a series of file pointer records and a text record. The volume descriptor record identifies the logical volume and the number of files it contains. A text record follows the volume descriptor record and identifies the data contained in the logical volume. There is a file pointer record for each type of data in the logical volume which indicates each file class, format and attributes.

Leader File

The leader file is composed of a file descriptor record and two types of data records. The data records are header and ancillary. Header record contains information related to mission, sensor, calibration coefficients and processing parameters. Ancillary records contain information pertaining to ephemeris, attitude, map projection, GCPs for image correction and image location and annotation.

Image file

Image file consists of file descriptor record and actual image record. Image data contains actual video data in BIL format (or) BSQ format. In addition to the image or video data, it also contains pixel counts, scan line identification, starting and ending of actual data in the line.

Trailer file

The trailer file shows the calibration data file and ancillary information file. This is composed of a file descriptor record and one trailer record for each band.

Null volume directory file

The file which terminates a logical volume is null volume directory file. The file is referred to as 'NULL' because it identifies a non existent logical volume. This file consists of a volume descriptor record only.

File 0	5 Records 360 Bytes	Volume Directory file (volume descriptor, file pointers and text record).
File 1	* Variable no of records	Leader file (descriptor, header, ancillary, calibration, histogram, map projection, GCP, anotation record, boundary record and boundary annotation record.)
	6120 bytes	Class LEAD
File 2	* Variable no. of records * Variable record length	Image Data file (Raw or Standard or Geocoded) Class IMGY
File 3	5 Records 360 Bytes	Trailer file (description and trailer records) CLASS-TRAI
NULL	One Record (360 bytees)	Null file (end of logical volume will be overwritten to add another logical volume.)

* No. of records and record length will vary as per the product or number of bands or sensors.

Table 4.5.1 Structure of files and records in UCCT

4.5.2 CARTRIDGE PRODUCTS

Introduction

With the availability of cartridge tape drives, data on magnetic tape medium can be provided in an inexpensive and compact manner. Cartridge drives are less expensive than normal tape drives and they provide almost the same, some times more capacity than normal tape medium. Hence, there is a need to supply satellite data on cartridge tapes. Specifications of Cartridge tape drives are given Tables 4.5.2 and 4.5.3.

Recording mechanism	:	Horizontal 9 tracks, with Read after write
Recording code	:	GCR
Recording format	:	Digital, QIC-150 and QIC-525
Capacity	:	150 MB / 525 MB
Recording Density	:	8,000 BPI
Tape speed	:	90 IPS
MTBF	:	25,000 Hrs
MTTR	:	30 mts
Make	:	3M, SONY

Table 4.5.2 Specifications of 150 / 525 MB Cartridge tape drive

Type	:	8 mm Cartridge Tape
Recording mechanism	:	Helical Scan with Read after write
Recording Format	:	Digital with error correcting code
Capacity (112M)	:	5 GB per tape
Recording Density	:	35 million bits / Sq. inch
Tape Speed	:	0.458 IPS
Rotor Speed	:	1800 RPM
Rewind Speed	:	32.7 IPS
MTBF	:	160,000 Hrs
MTTR	:	30 mts.
Make	:	3M,SONY,EXABYTE

Table 4.5.3 Specifications of 8 mm Digital Audio Tape drive

Data Organisation on the Cartridge

The cartridge products essentially follow the same LGSOWG format & FAST FORMAT in which the input CCTs of different sensors exist. The only deviation is that, the files on cartridge are named according to their respective contents.

4.5.3 FLOPPY PRODUCTS

The floppy products are supplied on the standard 3 1/2 inch floppies of 1.44 MB.

The user area for which the floppy data is required may be specified in terms of scene centre of the user's area of interest (or) corner coordinates of user's area of interest in latitude and longitude.If the user input is the scene centre, then, the area corresponding to 1Kx1K will be extracted around this point.However,if the user's input is corner coordinates, to account for the locational inaccuracy, extra area of .85' is added on all four sides and further it will be segmented into 1Kx1K size and the same will be supplied to the user. Extra area to account for the locational inaccuracy, will however not be provided in case the floppy area is extracted around the scene centre of the area specified by the user. Area coverage of floppy products are given in Table 4.5.4. The entire floppy data is copied in two files and the first file gives the annotation details.

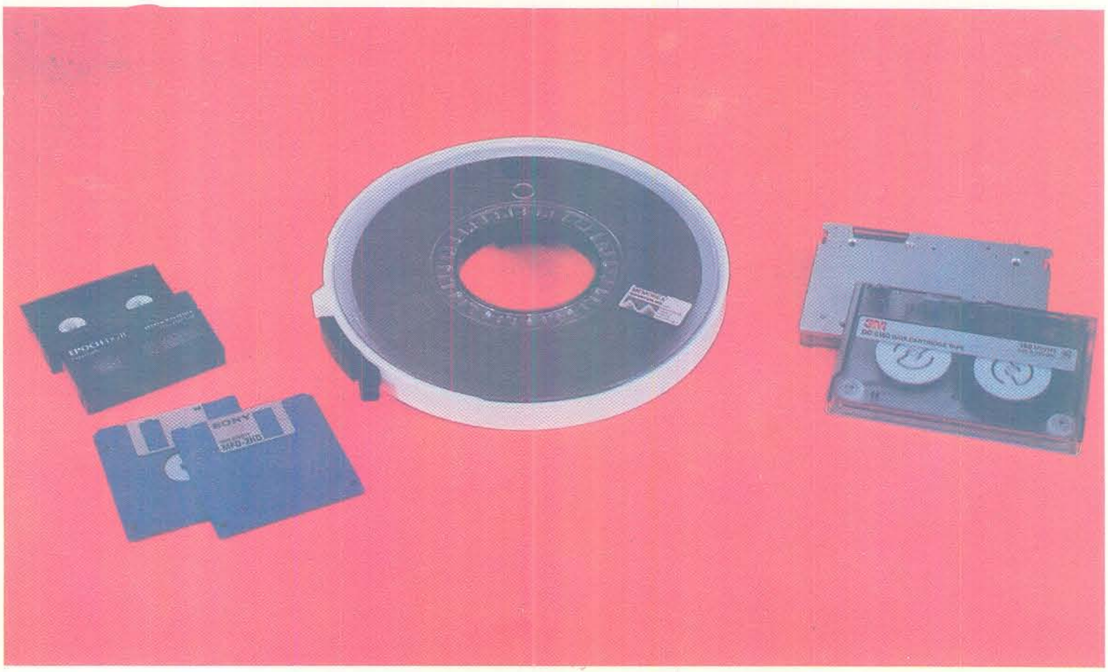
It may be noted that :

1. The floppy products are supplied only with "Bulk Correction".
2. The floppy products are supplied for a single band.
3. No floppy products are available for special products.

Table 4.5.5 gives a summary of all the digital products that will be supplied.

Sensor	Area covered in Sq.Km.	Area covered Lat and Long
LISS-III	24.576	13.4'x13.4'
PAN	6.4	3.5'x3.5'
WiFS	184.32	100.5'x100.5'

Table 4.5.4 Floppy area coverage



Digital data products

Table 4.5.5 Digital data products

Type of Product	Sensor	Media	Capacity	Format	No. of pixels	Physical volumes	Area (Km x Km)
STANDARD PRODUCTS							
Standard P/R, Shift along track, and Quadrant products	LISSIII	CCT	6250 BPI	BIL/BSQ LGSOWG format & BSQ Fast format	6500x6500	2	141x141
					3300x3300 (quadrant products)	1	72x72
		Cartridge Tape	150/ 525MB	BIL/BSQ LGSOWG format & BSQ Fast format	6500x6500	2/1	141x141
					3300x3300 (quadrant products)	1	72 x 72
		8mm DAT	5GB	BIL/BSQ LGSOWG format & BSQ Fast format	6500x6500	1	141x141
					3300x3300 (quadrant products)	1	72 x 72
Standard Product	LISS-III	3 1/2"Floppy (single band)	1.44 MB		1024x1024	1	24.576 x 24.576 ; 73x73 (SWIR)
Geocoded	LISS-III	CCT	1600/ 6250 BPI	BIL/BSQ LGSOWG format & & BSQ Fast format	1250x1250	1	28x28
		Cartridge Tape	150/ 525 MB	BIL/BSQ LGSOWG format & BSQ Fast format	1250x1250	1	28x28
		8mm DAT	5GB	BIL/BSQ LGSOWG format & BSQ fast format	1250X1250	1	28 X 28

Table 4.5.5 Digital data products (continued)

Type of Product	Sensor	Media	Capacity	Format	No. of pixels	Physical volumes	Area (Km x Km)
Standard P/R, Shift along track, and Quadrant products	PAN Subscene	CCT	1600/6250 BPI	BIL/BSQ LGSOWG format & BSQ Fast format	4500x4500 Nadir 5500x5500 off-nadir	1	23.9x23.9 Nadir 30.5x23.9 off-nadir
		Cartridge Tape	150/ 525 MB	BIL/BSQ LGSOWG format & BSQ Fast format	4500x4500 Nadir 5500x5500 off-nadir	1	23.9x23.9 Nadir 30.5x23.9 off-nadir
		8mm DAT	5GB	BIL/BSQ LGSOWG format & BSQ Fast format	4500x4500 Nadir 5500x5500 off-nadir	1	23.9x23.9 Nadir 30.5x23.9 off-nadir
Standard Product	PAN subscene	3 1/2" Floppy (single band)	1.44 MB		1024x1024	1	6.4 x 6.4
Geocoded	PAN subscene	CCT	1600/ 6250 BPI	BIL/BSQ LGSOWG format & BSQ Fast format	2500x2500	1	14x14
		Cartridge Tape	150/ 525MB	BIL/BSQ LGSOWG format & BSQ Fast format	2500x2500	1	14x14
		8mm DAT	5GB	BIL/BSQ LGSOWG format & BSQ Fast format	2500x2500	1	14x14

Table 4.5.5 Digital data products (continued)

Type of Product	Sensor	Media	Capacity	Format	No. of pixels	Physical volumes	Area (Km x Km)
Basic Stereo product	PAN subscene	CCT	1600/ 6250 BPI	LGSOWG format & Fast format	4200x4200	1	23.9x23.9
		Cartridge Tape	150/525 MB	LGSOWG format & Fast format	4200x4200	1	23.9x23.9
		8mm DAT	5GB	LGSOWG format & Fast format	4200x4200	1	23.9x23.9
Standard P/R, Shift along track products	WiFS	CCT	1600/ 6250 BPI	BIL/BSQ LGSOWG format & BSQ Fast format	5000x5000	2/1	810x810
		Cartridge Tape	150/ 525MB	BIL/BSQ LGSOWG format & BSQ Fast format	5000x5000	1	810x810
		8mm DAT	5GB	BIL/BSQ LGSOWG format & BSQ Fast format	5000x5000	1	810x810
Standard Product	WiFS	3 1/2" Floppy (single band)	1.44 MB		1024x1024	1	184.32 x 184.32

Table 4.5.5 Digital data products (continued)

Type of Product	Sensor	Media	Capacity	Format	No. of pixels	Physical volumes	Area (Km x Km)
SPECIAL PRODUCTS							
Dist geocoded product	LISSIII	CCT	6250 BPI	BIL/BSQ LGSOWG format & BSQ Fast format	1800x1800 (class A)	1	45x45
					3600x3600 (class B)	1	90x90
					7200x7200 (class C)	2	180x180
					8000x8000 (class D)	2	400x400
		Cartridge Tape	150/525 MB	BIL/BSQ LGSOWG format & BSQ Fast format	1800x1800 (class A)	1	45x45
					3600x3600 (class B)	1	90x90
					7200x7200 (class C)	2/1	180x180
					8000x8000 (class D)	2/1	400x400
		8mm DAT	5GB	BIL/BSQ LGSOWG format & BSQ Fast format	1800x1800 (class A)	1	45x45
					3600x3600 (class B)	1	90x90
					7200x7200 (class C)	1	180x180
					8000x8000 (class D)	1	400x400
PAN Full/ Shift along track products	PAN	CCT	6250 BPI	LGSOWG format & Fast format	12500x12500	2	70x70 (nadir)
					16500x16500	3	90x70 (off-nadir)
		Cartridge Tape	150/525 MB	LGSOWG format & Fast format	12500x12500	2/1	70x70 (Nadir)
					16500x16500	3/1	90x70 (off nadir)

Table 4.5.5 Digital data products (continued)

Type of Product	Sensor	Media	Capacity	Format	No. of pixels	Physical volumes	Area (Km x Km)
		8mm DAT	5GB	LGSOWG format & Fast format	12500x12500 16500x16500	1 1	70x70 (Nadir) 90x70
PAN Quadrant products	PAN	CCT	1600/ 6250 BPI	LGSOWG format & Fast format	6600x6600 8200x8200	2/1 2/1	36x36 (nadir) 46x36 (off-nadir)
		Cartridge Tape	150/525 MB	LGSOWG format & Fast format	6600x6600 8200x8200	2/1 2/1	36x36 (Nadir) 46x36
		8mm DAT	5GB	LGSOWG format & Fast format	6600x6600 8200x8200	2/1 2/1	36x36 (Nadir) 46x36
WiFS Zonal products	WiFS	CCT	6250 BPI	BIL/BSQ LGSOWG format & BSQ Fast format	7200x7200	1	1150x1150
		Cartridge Tape	150/525 MB	BIL/BSQ LGSOWG format & BSQ Fast format	7200x7200	1	1150x1150
		8mm DAT	5GB	BIL/BSQ LGSOWG format& BSQ Fast format	7200x7200	1	1150x1150

5. DATA DISTRIBUTION

5.1 INTRODUCTION

The increasing user awareness about the capabilities of Indian remote sensing programme for mapping and monitoring natural resources has lead to wide-spread interest in using IRS data products. This section provides the information needed to obtain IRS-1C data products and describes the services and facilities that will be available to users.

Users can obtain IRS-1C data from NRSA Data Centre (NDC) or Earth Observation Satellite Company (EOSAT) or Foreign Direct Receiving Stations (FDRSs).

5.2 NRSA DATA CENTRE

The NRSA Data Centre will provide access to the IRS-1C data products. The main functions of NDC are:

* to provide information required for procurement of satellite data products. This includes the description and specifications of different types of products, changes in product specifications from time to time, price lists, reference maps, accession catalogues, orbital calendars, orderforms etc.,.

* to provide assistance in the selection of appropriate data and checking the same for data quality and cloud-cover using browse facilities.

* to process orders and co-ordinate the generation of products at different work centres within the organisation.

* to check the quality of the final products before despatching

* billing and accounts.

* to promote awareness of remote sensing through publications, seminars, exhibitions etc.,.

NDC will also handle all payload programming related activities which are discussed in detail in 5.8.

5.3 EARTH OBSERVATION SATELLITE COMPANY (EOSAT)

The Earth Observation Satellite Company, U.S.A., is involved in the distribution of Landsat data and of late, IRS-1B and IRS-P2 data products. The Department of Space, Government of India, entered into a marketing agreement with the company. As per the agreement EOSAT will acquire IRS-1C data at its ground station at Norman, Oklahoma, U.S.A. and distribute the data worldwide.

EOSAT's exclusive marketing territory will consist of the entire world outside the coverage area of NRSA antenna. The non-exclusive territory consists of the coverage area of NRSA antenna except India.

5.4 FOREIGN DIRECT RECEIVING STATIONS (FDRS)

EOSAT, with the help of DOS, will setup a number of Foreign Data Receiving Stations (FDRSs) all over the world to receive IRS-1C data. These will be either the existing Landsat/SPOT data receiving stations which will be suitably upgraded to receive IRS-1C data, or, new receiving stations. The FDRSs will interact with NDC for all their data requirements

5.5 DATA DISSEMINATION

NDC will distribute IRS-1C data products pertaining to Shadnagar earth station coverage (henceforth referred to as NRSA IRS data) to Indian and foreign users. For areas outside India, but within the Shadnagar earth station coverage, users may approach EOSAT also.

For areas outside Shadnagar earth station coverage, users can approach either EOSAT or the corresponding FDRS for obtaining the data.

Figure 5.5.1 gives the details of IRS-1C data dissemination by various organisations.

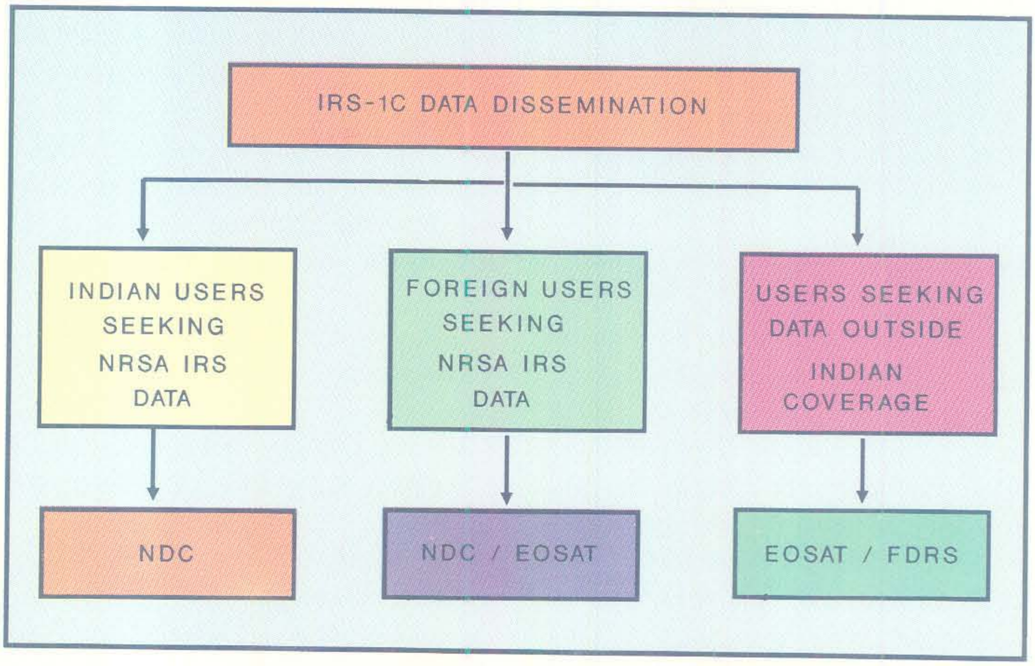


Figure 5.5.1 IRS-1C data dissemination

5.6 DATA ARCHIVAL AND AVAILABILITY

Raw data acquired by NRSA from all the sensors will be archived in the form of HDTs. Regarding processed photoproducts, only master films of geocoded and fixed full scenes will be archived.

Information on all IRS-1C data accessions archived at NDC, will be available in the form of catalogues through floppy media which are updated periodically. Specific information on data availability of user identified area with the desired cloud cover, data quality and period will be provided through the IIMS.

5.6.1 Global accession database

It is planned to maintain a database of all IRS-1C accesssions acquired all over the world by the various data receiving stations. The database will be maintained at NDC and EOSAT. The FDRSs and NRSA/EOSAT will send the details of data accessions to EOSAT/NRSA on Catalogue CCTs periodically and will be loaded into the IIMS. Users all over the world can approach NDC or EOSAT for information on data availability. However, they have to approach the concerned organisation for obtaining the data.

5.6.2 Auto cloud cover estimation

During IRS-1C time frame, it is planned to implement a software for auto cloud/snow cover estimation and an expert system for converting the results of the software into effective cloud/snow cover values. This will avoid manual cloud cover estimation at NDC. Using the expert system, NDC will have the provision for taking the following outputs (as computer printouts or on floppies) :

* cloud/snow cover estimate for a given mapsheet or quadrant
* Bit map printouts showing cloud covered areas for given full/quadrant scene/mapsheet.

Using the software, NDC will be able to prepare data availability listing for the users.

5.7 DIGITAL BROWSE FACILITY

A Digital Browse Facility will be made available at NDC, wherein, users can browse the image for deciding the acceptability of the image with respect to the distribution of cloud cover over the scene, percentage of cloud and data quality.

LISS-III and PAN browse images will be generated and compressed at the Browse Processing System by the next day morning of the day of acquisition and transferred to NDC via Network for archiving the data on optical jukebox. The optical jukebox will provide online storage of browse data for the entire mission period. The block diagram of the system is given in the Figure 5.7.1. Multiple browsing stations will be connected via Novell Netware Fileserver simultaneously.

Menu driven browsing software will be provided on each station for browsing the images of the selected sensor. This software will provide various options like single scene of specific date/path/row/sensor, all scenes of the path/sensor, same scene of different cycles etc.,. .Based on the user input, the requested data will be retrieved from the jukebox, decompressed and displayed, alongwith the corresponding annotation on the monitor. Annotation will consist of date of pass, path, row, satellite, sensor, scene center coordinates and quality. Overlay for mapsheet/ selected area (by giving four corner coordinates) will also be provided. Data manipulation like enhancement, zooming, compression can also be carried out.

LISS-III browse images will consist of 512 X 512 pixels and will be made available in colour (3 bands) while PAN and WiFS browse data will be of 1024 X 1024 pixels. WiFS browse data will be of Band 3. The browse image format for the various sensors is given in Figure 5.7.2 and 5.7.3.

Digital Browse facility

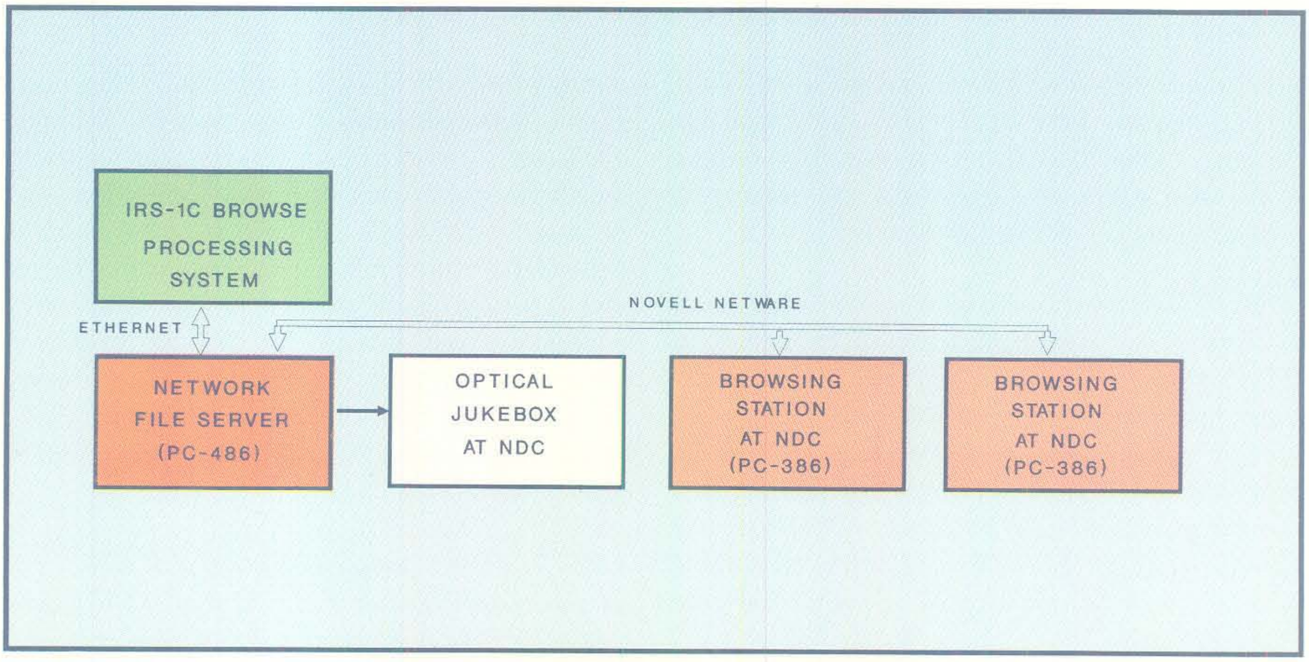


Figure. 5.7.1 Digital browse facility

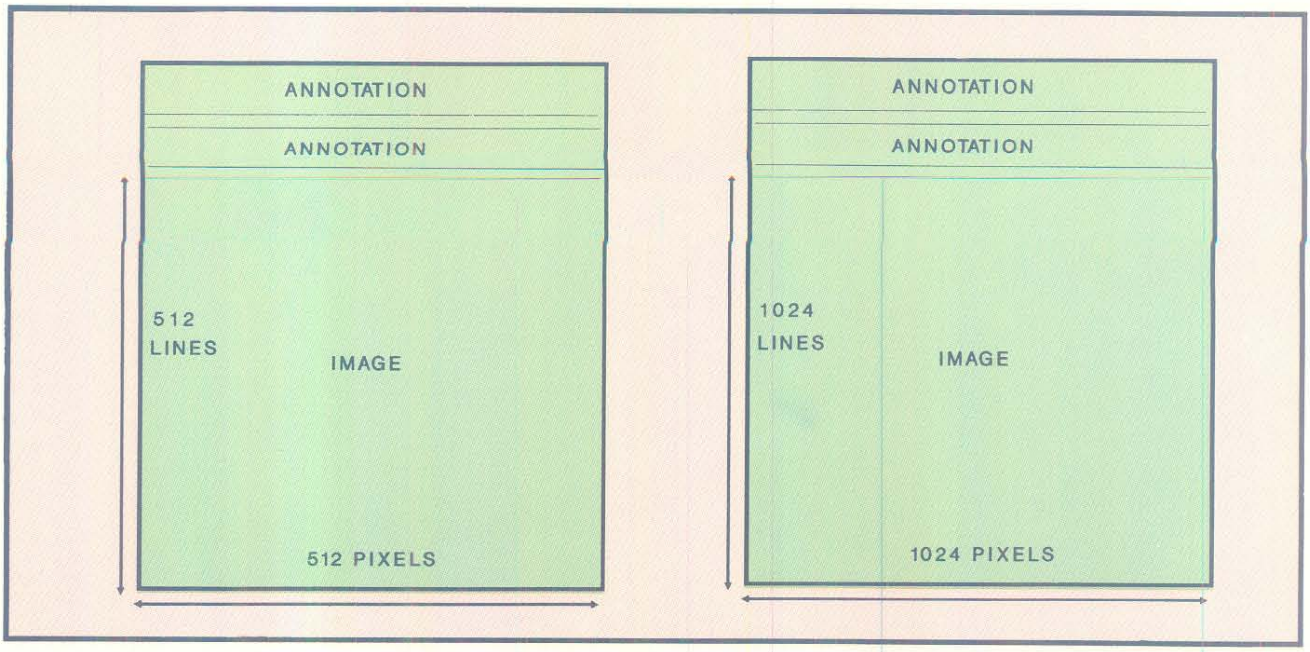


Figure. 5.7.2 LISS-III Digital browse image format

Figure. 5.7.3 PAN/WiFS Digital browse image format

5.8 ORDERING INFORMATION

5.8.1 ORDERING DATA

Orders for data supply will be accepted by NDC from Government organisations, academic institutions, industries and individuals in India and abroad. Orders may be placed with NDC in the prescribed format (Figure 5.8.1). Orders will be taken up for product generation when all the necessary information and full payment have been received from the customer. On receiving the payment, each customer is assigned an account number to which reference should be made in all future transactions.

5.8.2. STANDING ACCOUNTS

Standing accounts may be established by customers who need products frequently. A standing account may be opened by advance deposit of funds with NDC. The customer will be given an account number against which all subsequent orders will be processed. Status of standing account will be provided alongwith every invoice. Funds may be added to, or, a refund of the unused amount can be obtained at any time. Processing and supply of orders will be restricted to the extent of balance amount existing in the standing account.

5.8.3 PAYMENT

All orders for supply of data products must be accompanied by full advance payment in the form of bank draft and must be made payable to NRSA. Payment in cash will not be accepted. In the case of standing accounts, the authorised account identification should be sent to enable processing of order under the account.

Foreign payments have to be made in US dollars at rates indicated in the price list for supply of products to foreign users. All remittances may be credited to ANZ Grindlays Bank, 1177 Avenue of the Americas, New York NY 10036, U.S.A. (Telex : 667559 ; Fax : (212) 801 9859), under advice to ANZ Grindlays Bank plc, Hyderabad (Telex : 0425-6219 ; Fax : 0091 40-203734 marked to the attention of the Relationship Manager), in the following format :

TELECREDIT USD ________________ TO ANZ GRINDLAYS BANK, MADRAS 001313, 00001 CHIPS 232293 FOR CREDIT TO NRSA, HYDERABAD, INDIA.

It may be noted that the date of full remittance of funds to NRSA is treated as the effective date of placement of order.

5.8.4 PLACING A STANDING REQUEST

A standing request is intended to ensure supply of desired data products pertaining to future dates. Automatic generation and supply of data as they are acquired is the most expeditious method for obtaining data that meets the customer's requirements. A standing account must be established and maintained to satisfy the prepayment requirements for such orders.

Two options are exercised by the customer for placing standing orders. The customer may either specify the area and cloud cover limitation for which products are to be automatically generated and shipped, or, the user can confirm the order after receiving information about the new acquisitions. For exercising the first option, a standing account should be opened.

5.8.5 CUSTOMER PRODUCTS

Processing of data to unique scales or formats is available on selective basis and this must be specified explicitly.

Sat	Sensor Sub-scene	Path/ Orbit	Row/ Sect	Topo sheet/ Quad/ %shift/ B/H ratio	District /State name/ Zone No.				Segment size	Date of pass	Product code	Bands/Band combination		Unit price Rs.	Quantity	Value Rs.
					Latitude		Longitude									
					From	To	From	To				B/W	BGR			
1	2	3	4	5	6				7	8	9	10A	10B	11	12	13
														Total		

Figure 5.8.1 Data request form

Guidelines to fill data request form

Please read the following guidelines before filling the order form. Please use separate rows for each product. Do not club several products in one row.

1. Specify the satellite (IRS, LANDSAT, SPOT, NOAA, ERS, IRS-1C)

2. Specify the sensor (MSS, TM for LANDSAT; MLA, PLA for SPOT ; LISS-I, LISS-II for IRS-1A/1B; AVHRR, TOVS for NOAA; SAR for ERS-1; In case of IRS-1C, LISS-III 3 for visible band resolution and M for SWIR band resolution, PAN, WiFS) or subscene in case of IRS-1A/1B/ P2 LISS-II (A1,A2,B1,B2); in case of IRS-1C PAN (A1 to A9, B1 to B9, C1 to C9, D1 to D9))

3. Specify the Path or Orbit (Orbit in case of NOAA)

4. Specify the Row or Sector (Sector in the case of NOAA)

5. Specify the Toposheet number or Quadrant number (Toposheet number in case of geocoded products; Quadrant number in case of TM standard CCT/Cartridge, Quadrant number A,B,C,D in case of PAN), percentage of shift in increments of 10% in case of SAT products and B/H ratio in the case of stereopair products.

6&7 Specify the latitude/longitude values and segment size or district/state name or zone number.

8 Specify the date of pass

9 Specify the product code as per the current price list.

10a Specify the band number for B/W products or 1k x1k floppy products.

10b Specify the band combination for FCC.

11 Specify the unit price

12 Specify the quantity.

13. Specify the value of products ordered by multiplying columns 11 and 12.

5.8.6 PRODUCT CODE

Each product is identified by a unique nine letter code. Table 5.8.1 gives the scheme used in arriving at the code of a product. Detailed list of type of product and its product code is given in Annexure 1.

PRODUCT	PROJ	RESAM	ENHAN	PROC LEV	FORMAT	SIZE
ST Standard	0 No proj	0 No samp	00 No Enh	0 Raw	0 BW -Film 0	0 NA
QU Quadrant	P Polyconic	C CC	01 HLUT	1 Radcor	1 BW +Film	1 70mm
G3 15 min mapsheet	S SOM	N NN	02 Hist Eq	2 Bulk	2 BW Paper	2 240mm
G4 7.5 min mapsheet	U UTM (Ref.		VI Veg Index	3 Geom (partial)	3 Co -Film	3 500mm
SR Stereo	ellip-Int)		DQ DQE	6 DTM	4 Co +Film	4 960mm
TR Shift along track	V UTM (Ref				5 Co Paper	5 1000mm
MS.Multi sensor	ellip-Clarke)				6 LGSOWG BIL	6 1600bpi
DC District	R Stereoscopic				7 LGSOWG BSQ	7 6250 bpi
P1 Point based	L Lambert's				B FF BSQ	8 3 1/2" floppy DOS
ZL Zonal	confirmal					F Cart 150 MB UNIX
FU Full India	conical proj					H Cart 525 MB UNIX
J3 15 min Geocoded without SOI ref						I DAT 5 GB 8mm
J4 7.5 min Geocoded without SOI ref						
O4 Orthoimage						

Table 5.8.1 Product code scheme

5.9 PAYLOAD PROGRAMMING

5.9.1. INTRODUCTION

The three main features of IRS-1C which lead to the programming of the satellite are :

Steerable nature of the PAN camera.
On Board Tape Recorder (OBTR) and
FDRS to receive IRS-1C data

The PAN camera can be steered to $\pm 26^0$ whereby a strip of 70 Km can be viewed within 398 Km on either side of the satellite track.This capability of PAN allows high revisit of an area and stereoscopic viewing. The revisit capability varies with latitude. For eg. at equator, a given area can be imaged 7 times during an orbital cycle of 24 days. (refer Figure.2.4.4)

In the real-time mode, a ground station can acquire data from any/all of the three sensors viz. PAN, LISS-III and WiFS by setting to any one of the seven possible modes of real-time acquisition. (Table-5.9.1).

MODE	PAN	LISS-III	WiFS
1	+	+	+
2	+	+	
3	+		
4		+	
5		+	+
6	+		+
7			+

Mode 1 is the normal mode.

Table 5.9.1 Modes of acquiring real time data

It is possible to acquire data outside the visibility region of the Indian ground station through an On Board Tape Recorder (OBTR). The OBTR will be able to record and store data collected in 24 minutes. Data can either be recorded continuously for 24 minutes or in segments as required. LISS-III and WiFS data can be recorded simultaneouly, but, these cameras cannot be recorded while recording PAN data. The five modes in which it can be operated is given in Table-5.9.2. Data recorded on the OBTR will be downlinked to the Indian data receiving station only during night passes and products will be supplied as per user's requirements.

MODE	PAN I	PAN Q	LISS-III	WiFS
1	+			
2		+		
3			+	+
4			+	
5				+

Table 5.9.2 Modes of operating OBTR

FDRS's will receive data, in the real-time mode, over areas which fall within their visibility zone. FDRS's will inteface with NRSA Data Centre (NDC) for all their requirements for the acquisition of the data.

5.9.2 PROGRAMMING REQUESTS

General Users - Users send their Programming Requests (PR) to NDC (Figure 5.9.2). The PR is checked for its completeness , feasibility and also for the availability of data in archives which could satisfy the PR. The feasibility of a PR depends on technical constraints like specular reflection, the possible conflicts with other programming requests, climatic conditions of the area of interest etc.,. When a PR is considered feasible, a programming proposal is sent to the user with a quotation of the programming cost. The user confirms his/her acceptance by signing the programming proposal. The PRs from various users are carefully studied and priorities are assigned depending on type of service,product, acquisition mode etc.,. Based on these priorities, an optimal acquisition plan is prepared for the acquisition of every pass . The user is informed about the acquisition of his pass.NDC will send the acquisition plans to the Spacecraft Controlling Centre (SCC), where the necessary commands for the satellite to acquire/transmit the data will be worked out. After the successful acquisition of a pass, a scene that meets the user's requirement fully is processed and the products will be delivered to the user.

FDRS - A programming request from FDRS will be sent to NDC on a weekly basis for a period of one week, 6 weeks in advance, before the first day of the specified week. The programming request will define the area proposed for programming for each pass.The confirmation for the same to FDRS will be sent by NDC on a weekly basis for 15 days before the first day of the specified week.NDC informs SCC of the passes that are planned for FDRS. SCC will accordingly generate the necessary commands for the satellite to acquire and transmit data to FDRS. SCC will also provide FDRS with the necessary information like state vectors, forecast schedules etc.,. for acquisition of data. After acquisition of each pass, FDRS will inform NDC about the status of the pass. An overall flowchart of the programming activities is shown in Figure. 5.9.1.

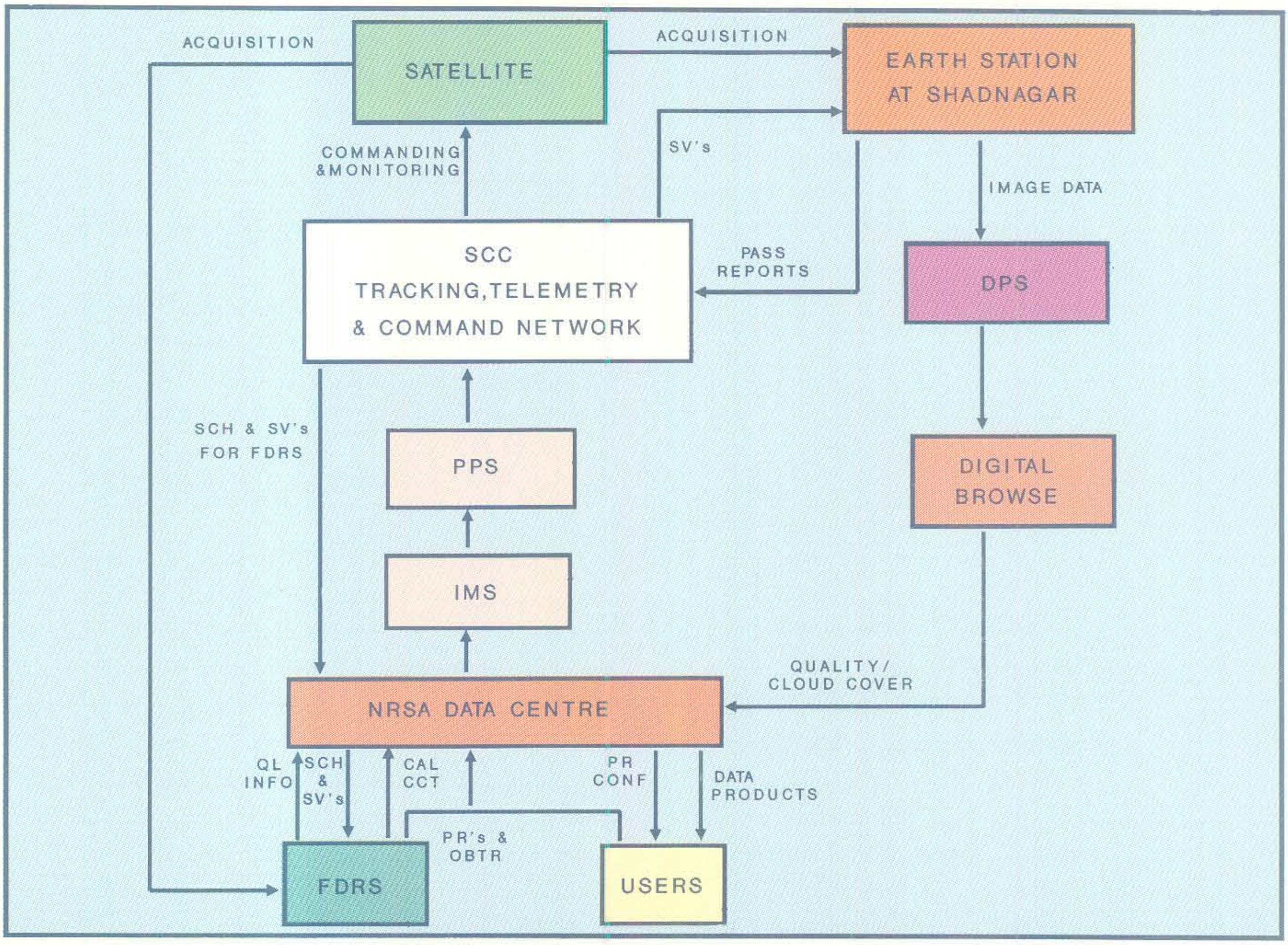


Figure 5.9.1 Programming activities

1. SERVICE :

ORD	URGENT
	NO.OF ATTEMPTS

2. TYPE OF ACQ

REAL TIME	OBTR

3. a. SURVEYING PERIOD :

	BEGIN	END
SINGLE PERIOD :		
ALTERNATE PERIOD :		

b. MULTITEMPORAL SURVEYING :

	I	II	III
BEGIN			
END			

4. SPECTRAL MODE :

PAN ☐ LISS-III ☐

5. SURVEYING METHOD :

ORDINARY	NADIR
	OFF-NADIR

	B/H RATIO FROM	B/H RATIO TO
STEREO		
TRIPLET		

6. CLOUD COVER : 0-10% ☐ 11-25% ☐ IRRESPECTIVE ☐

7. GEOGRAPHIC LOCATION OF AREA TO BE SURVEYED:
(POLYGON-GEOGRAPHIC CO-ORDINATES OF VERTICES)

	LAT.	LONG.		LAT.	LONG.
1.			6.		
2.			7.		
3.			8.		
4.			9.		
5.			10.		

	FROM	TO
PATH		
ROW		

MAPSHEET NO. ☐

8. REMARKS: ____________

9. SIG. WITH DATE :

NAME :
OFFICE :
ADDRESS:
PHONE : FAX :

Figure 5.9.2 Programming Request form

5.9.3 PROGRAMMING SERVICES

Two types of services - Urgent and Ordinary are planned. When an urgent service request is accepted, NDC guarantees to make an agreed number of attempts specified by the user within the programming period. This implies that no other urgent service PR can be entertained during this period.The urgent service request will be priced per attempt per scene irrespective of the resulting cloud cover in addition to the access fee.Besides, it is also obligatory for the user to purchase the products.An urgent service request is accepted only after analysing the satellite resources.

In the ordinary service, NDC will try its best to acquire the data over the required area as per user specifications. If the data is acquired successfully with less than 10% cloud and is of good quality, the user is required to purchase these products.

5.9.4 PROGRAMMING SEQUENCE AND TIMELINE

* Programming requests (PR) from users / FDRS have to reach NDC six weeks in advance before the period of acquisition.
* Programming proposal will be sent to the user for confirmation.
* NDC will send acquisition plan to SCC and PR confirmation to users/FDRS 15 days in advance.
* SCC will send Forecast schedule for a week to all data receiving stations/ NDC eleven days before the date of acquisition of the first pass on a weekly basis.
* Cancellation of any confirmed pass will be allowed till eight days before the day of acquisition.
* State vector information will be transmitted to FDRS by NDC two days before the day of acquisition.
* All the data reception stations will inform NDC about the status of the pass on the day of acquisition.

The timeline of the programming activities is shown in the Table 5.9.3.

Sl.No.	Day	User/FDRS to NDC	NDC to FDRS/User	NDC to SCC	SCC to NDC/FDRS
1	D-6 weeks	Programming request			
2.	D-15 days		Programming request confirmation	Acquisition plan for a week	
3	D-11 days				Forecast schedule for a week
4.	D-8 days	PR cancellations (if any)			
5.	D-5 days				General schedule for a week
6	D-3 days			Program plan (daily)	
7.	D-2 days		State vector transmission		Commanand schedule
8.	D	Pass performance report (by FDRS)			

Table 5.9.3 Programming sequence and timeline

5.10 DESPATCH OF DATA PRODUCTS

The data products are despatched, securely packed, by registered insured post or by air or by courier. Users could clearly specify the name and address to which products should be shipped. All shipments are prepaid and no postal charges are payable by the user. An invoice accompanies the data products showing the details of current debit as well as previous balance and current balance.

In the case of foreign orders, customs clearance and other formalities are the user's responsibility in his country. If desired, despatches can also be done through the user's representative in India.

5.11 USER FEEDBACK

The users are encouraged to keep the NRSA Data Centre informed about their experience with the data products supplied to them. Such feed back will be continuously analysed to improve the quality and services.

APPENDICES

I. IRS-1C PRODUCT CODES

STANDARD PRODUCTS

A LISS-III PRODUCTS

1. PATH/ROW PRODUCTS

AREA COVERED: B2/B3/B4 : 141*141Km.
B5 (SWIR) : 148*141Km.(Applicable to B/W products)

PRODUCT CODE POL	SOM	DESCRIPTION
1.1. B/W PRODUCTS PER BAND		
STPC00202	STSC00202	1:1m 240mm film negative
STPC00212	STSC00212	1:1m 240mm film positive
STPC00222	STSC00222	1:1m 240mmpaper print (1X print)
STPC00223	STSC00223	1:500,000480mm paper print (2X print)
STPC00224	STSC00224	1:250,000 960mm paper print (4X print)
1.2 FALSE COLOUR COMPOSITE (FCC) IN VISIBLE BAND RESOLUTION		
STPC00232	STSC00232	1:1M 240mm film negative
STPC00242	STSC00242	1:1M 240mm film positive
STPC00252	STSC00252	1:1M 240mm paper print (1X print)
STPC00253	STSC00253	1:500,000 480mm paper print (2X print)
STPC00254	STSC00254	1:250,000 960mm paper print (4X print)
1.3 DIGITAL PRODUCTS WITH BIL LGSOWG FORMAT		
STPC00267	STSC00267	CCT 6250 BPI
STPC0026F	STSC0026F	CRT 150 MB UNIX
STPC0026H	STSC0026H	CRT 525 MB UNIX
STPC0026I	STSC0026I	DAT 8MM 5GB
1.4 DIGITAL PRODUCTS WITH BSQ LGSOWG FORMAT		
STPC00277	STSC00277	CCT 6250 BPI
STPC0027F	STSC0027F	CRT 150 MB UNIX
STPC0027H	STSC0027H	CRT 525 MB UNIX
STPC0027I	STSC0027I	DAT 8MM 5GB

1.5 DIGITAL PRODUCTS WITH BSQ FAST FORMAT

STPC002B7	STSC002B7	CCT 6250 BPI
STPC002BF	STSC002BF	CRT 150 MB UNIX
STPC002BH	STSC002BH	CRT 525 MB UNIX
STPC002BI	STSC002BI	CRT 8MM 5GB

2. SHIFT ALONG TRACK PRODUCTS

AREA COVERED	:	B2/B3/B4	141 * 141Km.
		B5 (SWIR)	148 * 141Km.(Applicable in case of B/W products)

2.1. B/W PRODUCTS PER BAND

TRPC00202	TRSC00202	1:1m 240mm film negative
TRPC00212	TRSC00212	1:1m 240mm film positive
TRPC00222	TRSC00222	1:1m 240mm paper print (1X print)
TRPC00223	TRSC00223	1:500,000 480mm paper print (2X print)
TRPC00224	TRSC00224	1:250,000 960mm paper print (4X print)

2.2 FALSE COLOUR COMPOSITE (FCC) IN VISIBLE BAND RESOLUTION

TRPC00232	TRSC00232	1:1M 240mm film negative
TRPC00242	TRSC00242	1:1M 240mm film positive
TRPC00252	TRSC00252	1:1M 240mm paper print (1X print)
TRPC00253	TRSC00253	1:500,000 480mm paper print (2X print)
TRPC00254	TRSC00254	1:250,000 960mm paper print (4X print)

2.3 DIGITAL PRODUCTS WITH BIL LGSOWG FORMAT

TRPC00267	TRSC00267	CCT 6250 BPI
TRPC0026F	TRSC0026F	CRT 150 MB UNIX
TRPC0026H	TRSC0026H	CRT 525 MB UNIX
TRPC0026I	TRSC0026I	DAT 8MM 5GB

2.4 DIGITAL PRODUCTS WITH BSQ LGSOWG FORMAT

TRPC00277	TRSC00277	CCT 6250 BPI
TRPC0027F	TRSC0027F	CRT 150 MB UNIX
TRPC0027H	TRSC0027H	CRT 525 MB UNIX
TRPC0027I	TRSC0027I	DAT 8MM 5GB

2.5 DIGITAL PRODUCTS WITH BSQ FAST FORMAT

TRPC002B7	TRSC002B7	CCT 6250 BPI
TRPC002BF	TRSC002BF	CRT 150 MB UNIX
TRPC002BH	TRSC002BH	CRT 525 MB UNIX
TRPC002BI	TRSC002BI	DAT 8MM 5GB

3. QUADRANT PRODUCTS

AREA COVERED : 72 * 72 Km.

3.1. B/W PRODUCTS PER BAND

QUPC00202	QUSC00202	1: 500,000 240mm film negative
QUPC00212	QUSC00212	1: 500,000 240mm film positive
QUPC00222	QUSC00222	1: 500,000 240mm paper print (1X print)
QUPC00223	QUSC00223	1: 250,000 480mm paper print (2X print)
QUPC00224	QUSC00224	1: 125,000 960mm paper print (4X print)

* No quadrant products for SWIR band.

3.2 FALSE COLOUR COMPOSITE (FCC) IN VISIBLE BAND RESOLUTION

QUPC00232	QUSC00232	1: 500,000 240mm film negative
QUPC00242	QUSC00242	1: 500,000 240mm film positive
QUPC00252	QUSC00252	1: 500,000 240mm paper print (1X print)
QUPC00253	QUSC00253	1: 250,000 480mm paper print (2X print)
QUPC00254	QUPC00254	1: 125,000 960mm paper print (4X print)

3.3 DIGITAL PRODUCTS WITH BIL LGSOWG FORMAT

QUPC00267	QUSC00267	CCT 6250 BPI
QUPC0026F	QUSC0026F	CRT 150 MB UNIX
QUPC0026H	QUSC0026H	CRT 525 MB UNIX
QUPC0026I	QUSC0026I	DAT 8MM 5GB

3.4 DIGITAL PRODUCTS WITH BSQ LGSOWG FORMAT

QUPC00277	QUSC00277	CCT 6250 BPI
QUPC0027F	QUSC0027F	CRT 150 MB UNIX
QUPC0027H	QUSC0027H	CRT 525 MB UNIX
QUPC0027I	QUSC0027I	DAT 8MM 5GB

3.5 DIGITAL PRODUCTS WITH BSQ FAST FORMAT

QUPC002B7	QUSC002B7	CCT 6250 BPI
QUPC002BF	QUSC002BF	CRT 150 MB UNIX
QUPC002BH	QUSC002BH	CRT 525 MB UNIX
QUPC002BI	QUSC002BI	DAT 8MM 5GB

4. GEOCODED PRODUCTS

4.1 PHOTO PRODUCTS CORRESPONDING TO 15' X 15' SOI TOPOSHEET

G3PC00225	B/W band 1000mm paper print 1:50,000 (5X print)
G3PC00255	FCC 1000mm paper print 1:50,000 (5X print)

4.2 DIGITAL PRODUCTS WITH BIL LGSOWG FORMAT

G3PC00266	CCT 1600 BPI
G3PC00267	CCT 6250 BPI
G3PC0026F	CRT 150 MB UNIX
G3PC0026H	CRT 525 MB UNIX
G3PC0026I	DAT 8MM 5GB

4.3 DIGITAL PRODUCTS WITH BSQ LGSOWG FORMAT

G3PC00276	CCT 1600 BPI
G3PC00277	CCT 6250 BPI
G3PC0027F	CRT 150 MB UNIX
G3PC0027H	CRT 525 MB UNIX
G3PC0027I	DAT 8MM 5GB

4.4 DIGITAL PRODUCTS WITH BSQ FAST FORMAT

G3PC002B6	CCT 1600 BPI
G3PC002B7	CCT 6250 BPI
G3PC002BF	CRT 150 MB UNIX
G3PC002BH	CRT 525 MB UNIX
G3PC002BI	DAT 8MM 5GB

5. MINIATURE PRODUCTS (FLOPPY) BSQ 1K X 1K SIZE

AREA COVERED :	B2/B3/B4 :	24*24Km.Approx.(visible resolution)
	B5 :	73*73Km.Approx.(SWIR resolution)

STPC00278	STSC00278	Floppy 1.44MB DOS (3 1/2" * 3 1/2")

B. PAN PRODUCTS

1. PAN SUBSCENE (path/row)

AREA COVERED: NADIR : 23.9*23.9Km.
OFFNADIR : 30.5*23.9Km.

1.1.1 B/W PRODUCTS

STPC00202	STSC00202	1:250,000 240mm film negative
STPC00212	STSC00212	1:250,000 240mm film positive
STPC00222	STSC00222	1:250,000 240mm paper print (1X print)
STPC00223	STSC00223	1:125,000 480mm paper print (2X print)
STPC00224	STSC00224	1:50,000 960mm paper print (5X print)

1.1.2 DIGITAL PRODUCTS LGSOWG FORMAT

STPC00276	STSC00276	CCT 1600 BPI
STPC00277	STSC00277	CCT 6250 BPI
STPC0027F	STSC0027F	CRT 150 MB UNIX
STPC0027H	STSC0027H	CRT 525 MB UNIX
STPC0027I	STSC0027I	DAT 8MM 5GB

1.1.3 DIGITAL PRODUCTS FAST FORMAT

STPC002B6	STSC002B6	CCT 1600 BPI
STPC002B7	STSC002B7	CCT 6250 BPI
STPC002BF	STSC002BF	CRT 150 MB UNIX
STPC002BH	STSC002BH	CRT 525 MB UNIX
STPC002BI	STSC002BI	DAT 8MM 5GB

1.2.SHIFT ALONG TRACK PRODUCTS

AREA COVERED : NADIR : 23.9*23.9Km.
OFFNADIR : 30.5*23.9Km.

1.2.1 B/W PRODUCTS

TRPC00202	TRSC00202	1:250,000 240mm film negative
TRPC00212	TRSC00212	1:250,000 240mm film positive
TRPC00222	TRSC00222	1:250,000 240mm paper print (1X print)

TRPC00223	TRSC00223	1:125,000 480mm paper print (2X print)
TRPC00224	TRSC00224	1:50,000 960mm paper print (5X print)

1.2.2 DIGITAL PRODUCTS LGSOWG FORMAT

TRPC00276	TRSC00276	CCT 1600 BPI
TRPC00277	TRSC00277	CCT 6250 BPI
TRPC0027F	TRSC0027F	CRT 150 MB UNIX
TRPC0027H	TRSC0027H	CRT 525 MB UNIX
TRPC0027I	TRSC0027I	DAT 8MM 5GB

1.2.3 DIGITAL PRODUCTS FAST FORMAT

TRPC002B6	TRSC002B6	CCT 1600 BPI
TRPC002B7	TRSC002B7	CCT 6250 BPI
TRPC002BF	TRSC002BF	CRT 150 MB UNIX
TRPC002BH	TRSC002BH	CRT 525 MB UNIX
TRPC002BI	TRSC002BI	DAT 8MM 5GB

1.3. BASIC STEREO PRODUCTS (TWO PRODUCTS PER SCENE)

(Only Radiometric and no Geometric correction)

AREA COVERED:	NADIR	:	23.9*23.9Km.
	OFFNADIR	:	30.5*23.9Km.

1.3.1 B/W PRODUCT

SR0000102	1:250,000 240mm film negative
SR0000112	1:250,000 240mm film positive
SR0000122	1:250,000 240mm paper print (1X print)

1.3.2 DIGITAL PRODUCTS LGSOWG FORMAT

SR0000176	CCT 1600 BPI
SR0000177	CCT 6250 BPI
SR000017F	CRT 150 MB UNIX
SR000017H	CRT 525 MB UNIX
SR000017I	DAT 8MM 5GB

1.3.3 DIGITAL PRODUCTS WITH FAST FORMAT

SR00001B6	CCT 1600 BPI

SR00001B7	CCT 6250 BPI
SR00001BF	CRT 150 MB UNIX
SR00001BH	CRT 525 MB UNIX
SR00001BI	DAT 8MM 5GB

1.4 BASIC STEREO PRODUCTS (TWO PRODUCTS PER SCENE)

(Radiometric+Partial geometric)

AREA COVERED	:	NADIR	:	23.9*23.9Km.
		OFFNADIR	:	30.5*23.9Km.

1.4.1 B/W PRODUCTS:

SR0N00302	1:250,000 240mm film negative
SR0N00312	1:250,000 240mm film positive
SR0N00322	1:250,000 240mm paper print (1X print)

1.4.2 DIGITAL PRODUCTS LGSOWG FORMAT

SR0N00376	CCT 1600 BPI
SR0N00377	CCT 6250 BPI
SR0N0037F	CRT 150 MB UNIX
SR0N0037H	CRT 525 MB UNIX
SR0N0037I	DAT 8MM 5GB

1.4.3 DIGITAL PRODUCTS WITH FAST FORMAT

SR0N003B6	CCT 1600 BPI
SR0N003B7	CCT 6250 BPI
SR0N003BF	CRT 150 MB UNIX
SR0N003BH	CRT 525 MB UNIX
SR0N003BI	DAT 8MM 5GB

2.GEOCODED PRODUCTS

2.1 Photo products corresponding to 7 1/2' X 7 1/2' SOI toposheet

G4PC00225	B/W 1000mm paper print 1:25,000 (5X print)

2.2 Digital products corresponding to 7 1/2' X 7 1/2' SOI toposheet (LGSOWG FORMAT)

G4PC00276	CCT 1600 BPI

G4PC00277	CCT 6250 BPI
G4PC0027F	CRT 150 MB UNIX
G4PC0027H	CRT 525 MB UNIX
G4PC0027I	DAT 8MM 5GB

2.3 Digital products corresponding to 7 1/2' X 7 1/2' SOI toposheet (FAST FORMAT)

G4PC002B6	CCT 1600 BPI
G4PC002B7	CCT 6250 BPI
G4PC002BF	CRT 150 MB UNIX
G4PC002BH	CRT 525 MB UNIX
G4PC002BI	DAT 8MM 5GB

3. MINIATURE PRODUCTS FLOPPY 1K X 1K SIZE

AREA COVERED : 6.4 * 6.4 Km.

STPC00278	STSC00278	Floppy 1.44MB DOS (3 1/2" * 3 1/2")

C. WIFS PRODUCT

STANDARD PATH/ROW PRODUCTS

AREA COVERED : 810* 810 Km.

1.1. B/W PRODUCTS PER BAND

STLC00202	1:6m 240 mm film negative
STLC00212	1:6m 240 mm film positive
STLC00222	1:6m 240 mm paper print (1x print)
STLC00224	1:2m 960 mm paper print (3X print)

1.2 DIGITAL PRODUCTS WITH BIL LGSOWG FORMAT

STLC00266	CCT 1600 BPI
STLC00267	CCT 6250 BPI
STLC0026F	CRT 150 MB UNIX
STLC0026H	CRT 525 MB UNIX
STLC0026I	DAT 8MM 5GB

1.3 DIGITAL PRODUCTS WITH BSQ LGSOWG FORMAT

STLC00276	CCT 1600 BPI
STLC00277	CCT 6250 BPI
STLC0027F	CRT 150 MB UNIX
STLC0027H	CRT 525 MB UNIX
STLC0027I	DAT 8MM 5GB

1.4 DIGITAL PRODUCTS WITH BSQ FAST FORMAT

STLC002B6	CCT 1600 BPI
STLC002B7	CCT 6250 BPI
STLC002BF	CRT 150 MB UNIX
STLC002BH	CRT 525 MB UNIX
STLC002BI	DAT 8MM 5GB

2. SHIFT ALONG TRACK PRODUCTS

AREA COVERED : 810* 810 Km.

2.1. B/W PRODUCTS PER BAND

TRLC00202	1:6m 240 mm film negative
TRLC00212	1:6m 240 mm film positive
TRLC00222	1:6m 240 mm paper print (1X print)
TRLC00224	1:2m 960 mm paper print (3X print)

2.2 DIGITAL PRODUCTS WITH BIL LGSOWG FORMAT

TRLC00266	CCT 1600 BPI
TRLC00267	CCT 6250 BPI
TRLC0026F	CRT 150 MB UNIX
TRLC0026H	CRT 525 MB UNIX
TRLC0026I	DAT 8MM 5GB

2.3 DIGITAL PRODUCTS WITH BSQ LGSOWG FORMAT

TRLC00276	CCT 1600 BPI
TRLC00277	CCT 6250 BPI
TRLC0027F	CRT 150 MB UNIX
TRLC0027H	CRT 525 MB UNIX
TRLC0027I	DAT 8MM 5GB

2.4 DIGITAL PRODUCTS WITH BSQ FAST FORMAT

TRLC002B6	CCT 1600 BPI
TRLC002B7	CCT 6250 BPI
TRLC002BF	CRT 150 MB UNIX
TRLC002BH	CRT 525 MB UNIX
TRLC002BI	DAT 8MM 5GB

1.7 MINIATURE PRODUCTS (FLOPPY) BSQ 1K X 1K SIZE

AREA COVERED : 184 * 184Km.

STLC00278 Floppy 1.44MB DOS (3 1/2" * 3 1/2")

SPECIAL PRODUCTS

A. LISS-III SENSOR

1. LISS-III DISTRICT GEOCODED

1.1 B/W PRODUCTS

DCPC00222 1:250,000 480mm paper print (2X print)
(Dist. Geocoded class A) AREA COVERED: 45*45 Km
DCPC00223 1:250,000 480mm paper print (2X print)
(Dist. Geocoded class B) AREA COVERED: 90*90Km.
DCPC00224 1:250,000 960mm paper print (4X print)
(Dist. Geocoded class C) AREA COVERED : 180*180Km.
DCPC00225 1:500,000 960mm paper print (1X print)
(Dist.Geocoded Class D) AREA COVERED : 400*400Km.

1.2 FALSE COLOUR COMPOSITE (FCC) PRODUCTS

DCPC00252 1:250,000 480mm paper print (2X print)
(Dist. Geocoded class A) AREA COVERED : 45*45Km.
DCPC00253 1:250,000 480mm paper print (2X print)
(Dist. Geocoded class B) AREA COVERED : 90*90Km.
DCPC00254 1:250,000 960mm paper print (4X print)
(Dist. Geocoded class C) AREA COVERED: 180*180Km.
DCPC00255 1:500,000 960mm paper print (1X print)
(Dist. Geocoded class D) AREA COVERED : 400*400Km.

1.3 DIGITAL PRODUCTS WITH BIL LGSOWG FORMAT

DCPC00267	CCT 6250 BPI
DCPC0026F	CRT 150 MB UNIX
DCPC0026H	CRT 525 MB UNIX
DCPC0026I	DAT 8MM 5GB

1.4 DIGITAL PRODUCTS WITH BSQ LGSOWG FORMAT

DCPC00277	CCT 6250 BPI
DCPC0027F	CRT 150 MB UNIX
DCPC0027H	CRT 525 MB UNIX
DCPC0027I	DAT 8MM 5GB

1.5 DIGITAL PRODUCTS WITH BSQ FAST FORMAT

DCPC002B7	CCT 6250 BPI
DCPC002BF	CRT 150 MB UNIX
DCPC002BH	CRT 525 MB UNIX
DCPC002BI	DAT 8MM 5GB

B. PAN SENSOR

2. PAN 5min * 5min Geocoded Data

2.1 B/W PRODUCTS

P1PC00225 1:12,500 1000mm paper print (5X print)

3. PAN FULL SCENE (path/row)

AREA COVERED : NADIR : 70*70Km.
OFFNADIR : 90*70Km.

3.1 B/W PRODUCTS

STPC00204	STSC00204	1:125,000 960mm film negative
STPC00214	STSC00214	1:125,000 960mm film positive
STPC00224	STSC00224	1:125,000 960mm paper print (1X print)

3.2 DIGITAL PRODUCTS LGSOWG FORMAT

STPC00277	STSC00277	CCT 6250 BPI
STPC0027F	STSC0027F	CRT 150 MB UNIX
STPC0027H	STSC0027H	CRT 525 MB UNIX
STPC0027I	STSC0027I	DAT 8MM 5GB

3.3 DIGITAL PRODUCTS FAST FORMAT

STPC002B7	STSC002B7	CCT 6250 BPI
STPC002BF	STSC002BF	CRT 150 MB UNIX
STPC002BH	STSC002BH	CRT 525 MB UNIX
STPC002BI	STSC002BI	DAT 8MM 5GB

4. PAN FULL SCENE (SAT)

AREA COVERED :	NADIR	:	70*70 Km.
	OFFNADIR	:	90*70 Km.

4.1 B/W PRODUCTS

TRPC00204	TRSC00204	1:125,000 960mm Film negative
TRPC00214	TRSC00214	1:125,000 960mm Film positive
TRPC00224	TRSC00224	1:125,000 960mm paper print (1X print)

4.2 DIGITAL PRODUCTS LGSOWG FORMAT

TRPC00277	TRSC00277	CCT 6250 BPI
TRPC0027F	TRSC0027F	CRT 150 MB UNIX
TRPC0027H	TRSC0027H	CRT 525 MB UNIX
TRPC0027I	TRSC0027I	DAT 8MM 5GB

4.3 DIGITAL PRODUCTS FAST FORMAT

TRPC002B7	TRSC002B7	CCT 6250 BPI
TRPC002BF	TRSC002BF	CRT 150 MB UNIX
TRPC002BH	TRSC002BH	CRT 525 MB UNIX
TRPC002BI	TRSC002BI	DAT 8MM 5GB

5. PAN QUADRANT PRODUCTS (PAN I/PAN Q)

AREA COVERED : NADIR : 36 * 36 Km.
OFFNADIR : 46 * 36 Km.

5.1 B/W PRODUCTS

QUPC00204	QUSC00204	1:125,000 960mm film negative
QUPC00214	QUSC00214	1:125,000 960mm film positive
QUPC00224	QUSC00224	1:125,000 960mm paper print (1X print)

5.2 DIGITAL PRODUCTS LGSOWG FORMAT

QUPC00276	QUSC00276	CCT 1600 BPI
QUPC00277	QUSC00277	CCT 6250 BPI
QUPC0027F	QUSC0027F	CRT 150 MB UNIX
QUPC0027H	QUSC0027H	CRT 525 MB UNIX
QUPC0027I	QUSC0027I	DAT 8MM 5GB

5.3. DIGITAL PRODUCTS FAST FORMAT

QUPC002B6	QUSC002B6	CCT 1600 BPI
QUPC002B7	QUSC002B7	CCT 6250 BPI
QUPC002BF	QUSC002BF	CRT 150 MB UNIX
QUPC002BH	QUSC002BH	CRT 525 MB UNIX
QUPC002BI	QUSC002BI	DAT 8MM 5GB

6. ORTHOIMAGE PRODUCTS (7 1/2'*7 1/2'):

6.1 B/W.Products

O4PC00625 1:50,000 1000mm paper print (5X print)

C. LISS-III + PAN SENSOR

7. PAN+LISS-III MERGED PRODUCTS

AREA COVERED : 23.9 * 23.9 Km.

7.1 FALSE COLOUR COMPOSITE (FCC) PRODUCTS

MSPC00255	MSSC00255	1:25,000 1000mm paper print (5X print)

D. WiFS SENSOR

8. WiFS Zonal

AREA COVERED : 1150 * 1150Km.

8.1 B/W PRODUCTS

ZLLC00224	1:2M 960mm paper print (3.6X print)

8.2 DIGITAL PRODUCTS WITH BIL LGSOWG FORMAT

ZLLC00267	CCT 6250 BPI
ZLLC0026F	CRT 150 MB UNIX
ZLLC0026H	CRT 525 MB UNIX
ZLLC0026I	DAT 8MM 5GB

8.3 DIGITAL PRODUCTS WITH BSQ LGSOWG FORMAT

ZLLC00277	CCT 6250 BPI
ZLLC0027F	CRT 150 MB UNIX
ZLLC0027H	CRT 525 MB UNIX
ZLLC0027I	DAT 8MM 5GB

8.4 DIGITAL PRODUCTS WITH BSQ FAST FORMAT

ZLLC002B7	CCT 6250 BPI
ZLLC002BF	CRT 150 MB UNIX
ZLLC002BH	CRT 525 MB UNIX
ZLLC002BI	DAT 8MM 5GB

9. V I M FULL INDIA PRODUCTS

AREA COVERED : 3500 * 3500 Km.

9.1 FALSE COLOUR COMPOSITE (FCC) PRODUCTS

FULCVI255	1:6M 960mm paper print (1X print)

10. V I M ZONAL PRODUCTS

10.1 FALSE COLOUR COMPOSITE (FCC) PRODUCTS

ZLLCVI255	1:2M 960mm paper print (3.6X print)

NOTE

1. For standard digital products with Nearest Neighbour resampling, 4th character will be 'N' instead of 'C'.

2. Product code given here is only for common LUT. In case of Histo LUT products, replace the 5th and 6th characters of the product code with '01'.

3. For all LISS-III standard products in SWIR resolution, the sensor has to be mentioned as 'M' in the indent. However, the product code is the same as LISS-III products in visible band resolution.

4. UTM projection is available for scenes covering the neighbouring countries.Replace the 3rd character with 'U' instead of 'P' or 'S'.

5. For PAN Full scene products, the sensor should be mentioned as 'A','B','C' or 'D' in the order form. PAN Full scene products will be available on Large Film Format only.

6. The product code for stereotriplets is the same as Basic stereopair products.

7. For arriving at the product code for DQE products, replace the 5th and 6th characters of product code of digital products with 'DQ' instead of '00'.

8. In the case of scenes covering the polar regions, only Stereoscopic Projection is applicable.Replace the 3rd character of the product code with "R".

9. In the case of Histogram Equalization, replace the 6th character of the product code with "2".

10. In the case of Raw data products, only BIL, 6250BPI products in LGSOWG format will be supplied. For this, replace the 7th character of the product code with '0'.

11. In the case of Radiometrically corrected data products, only BIL 6250BPI products in LGSOWG format will be supplied. For this, replace the 7th character of the product code with '1'.

12. In the case of LISS-III, 15'x15' geocoded data not corresponding to SOI mapsheet (i.e. Outside India in particular), replace G3 as J3 of the Product code

13. In the case of PAN, 7 1/2' x 7 1/2' geocoded data not corresponding to SOI mapsheet (i.e. Outside India in particular), replace G4 as J4 of the Product code

II. DISTRICT CODE AND CLASS

State /UT	District Code	Class	District Name	State/Union Territory (UT) Name
AN	AN01	F	ANDAMAN	ANDAMAN & NICOBAR
AN	AN02	F	NICOBAR	ANDAMAN & NICOBAR
AP	AP01	D	ADILABAD	ANDHRA PRADESH
AP	AP02	D	ANANTAPUR	ANDHRA PRADESH
AP	AP03	D	CHITTOOR	ANDHRA PRADESH
AP	AP04	C	CUDDAPAH	ANDHRA PRADESH
AP	AP05	D	EAST GODAVARI	ANDHRA PRADESH
AP	AP06	D	GUNTUR	ANDHRA PRADESH
AP	AP07	A	HYDERABAD	ANDHRA PRADESH
AP	AP08	D	KARIMNAGAR	ANDHRA PRADESH
AP	AP09	D	KHAMMAM	ANDHRA PRADESH
AP	AP10	C	KRISHNA	ANDHRA PRADESH
AP	AP11	D	KURNOOL	ANDHRA PRADESH
AP	AP12	D	MAHBUBNAGAR	ANDHRA PRADESH
AP	AP13	C	MEDAK	ANDHRA PRADESH
AP	AP14	C	NALGONDA	ANDHRA PRADESH
AP	AP15	D	NELLORE	ANDHRA PRADESH
AP	AP16	C	NIZAMABAD	ANDHRA PRADESH
AP	AP17	D	PRAKASAM	ANDHRA PRADESH
AP	AP18	C	RANGAREDDY	ANDHRA PRADESH
AP	AP19	C	SRIKAKULAM	ANDHRA PRADESH
AP	AP20	C	VISHAKHAPATNAM	ANDHRA PRADESH
AP	AP21	C	VIZIANAGARAM	ANDHRA PRADESH
AP	AP22	D	WARANGAL	ANDHRA PRADESH
AP	AP23	C	WEST GODAVARI	ANDHRA PRADESH
AR	AR01	C	CHANGLANG	ARUNACHAL PRADESH
AR	AR02	C	DIBANG VALLEY	ARUNACHAL PRADESH
AR	AR03	B	EAST KAMENG	ARUNACHAL PRADESH
AR	AR04	C	EAST SIANG	ARUNACHAL PRADESH
AR	AR05	C	LOHIT	ARUNACHAL PRADESH
AR	AR06	C	LOWER SUBANSIRI	ARUNACHAL PRADESH
AR	AR07	B	TAWANG	ARUNACHAL PRADESH
AR	AR08	B	TIRAP	ARUNACHAL PRADESH
AR	AR09	C	UPPER SUBANSIRI	ARUNACHAL PRADESH
AR	AR10	C	WEST KAMENG	ARUNACHAL PRADESH
AR	AR11	D	WEST SIANG	ARUNACHAL PRADESH
AS	AS01	B	BARPETA	ASSAM
AS	AS02	F	BONGAIGAON	ASSAM
AS	AS03	C	CACHAR	ASSAM
AS	AS04	B	DARRANG	ASSAM
AS	AS05	F	DHEMAJI	ASSAM
AS	AS06	C	DHUBURI	ASSAM
AS	AS07	C	DIBRUGARH	ASSAM
AS	AS08	C	GOALPARA	ASSAM
AS	AS09	C	GOLAGHAT	ASSAM

AS	AS10	F	HAILAKANDI	ASSAM
AS	AS11	B	JORHAT	ASSAM
AS	AS12	C	KAMRUP	ASSAM
AS	AS13	C	KARBI ANGLONG	ASSAM
AS	AS14	C	KARIMGANJ	ASSAM
AS	AS15	C	KOKRAJHAR	ASSAM
AS	AS16	D	LAKHIMPUR	ASSAM
AS	AS17	F	MARIGAON	ASSAM
AS	AS18	C	NAGAON	ASSAM
AS	AS19	B	NALBARI	ASSAM
AS	AS20	B	NORTH CACHAR HILLS	ASSAM
AS	AS21	B	SIBSAGAR	ASSAM
AS	AS22	C	SONITPUR	ASSAM
AS	AS23	F	TINSUKIA	ASSAM
BH	BH01	F	ARARIA	BIHAR
BH	BH02	B	AURANGABAD	BIHAR
BH	BH03	F	BANKA	BIHAR
BH	BH04	B	BEGUSARAI	BIHAR
BH	BH05	F	BHABHUA	BIHAR
BH	BH06	C	BHAGALPUR	BIHAR
BH	BH07	C	BHOJPUR	BIHAR
BH	BH08	F	BOKARO	BIHAR
BH	BH09	F	BUXAR	BIHAR
BH	BH10	F	CHATRA	BIHAR
BH	BH11	B	CHHAPRA	BIHAR
BH	BH12	B	DARBHANGA	BIHAR
BH	BH13	B	DEVGHAR	BIHAR
BH	BH14	B	CHANBAD	BIHAR
BH	BH15	C	DUMKA	BIHAR
BH	BH16	F	GARHWA	BIHAR
BH	BH17	C	GAYA	BIHAR
BH	BH18	B	GIRIDIH	BIHAR
BH	BH19	B	GODDA	BIHAR
BH	BH20	C	GOPALGANJ	BIHAR
BH	BH21	C	GUMLA	BIHAR
BH	BH22	C	HAZARIBAG	BIHAR
BH	BH23	F	JAHANABAD	BIHAR
BH	BH24	F	JAMUI	BIHAR
BH	BH25	B	KATIHAR	BIHAR
BH	BH26	B	KHAGARIA	BIHAR
BH	BH27	F	KISHANGANJ	BIHAR
BH	BH28	B	LOHARDAGA	BIHAR
BH	BH29	B	MADHEPURA	BIHAR
BH	BH30	C	MADHUBANI	BIHAR
BH	BH31	B	MUNGER	BIHAR
BH	BH32	B	MUZAFFARPUR	BIHAR
BH	BH33	B	NALANDA	BIHAR
BH	BH34	B	NAWADA	BIHAR
BH	BH35	C	PALAMU	BIHAR
BH	BH36	F	PASHCHIM CHAMPARAN	BIHAR
BH	BH37	F	PASHCHIMI SINGHBHUM	BIHAR

BH	BH38	C	PATNA	BIHAR
BH	BH39	B	PURBA CHAMPARAN	BIHAR
BH	BH40	F	PURBI SINGHBHUM	BIHAR
BH	BH41	C	PURNIA	BIHAR
BH	BH42	C	RANCHI	BIHAR
BH	BH43	C	ROHTAS	BIHAR
BH	BH44	C	SAHARSA	BIHAR
BH	BH45	C	SAHIBGANJ	BIHAR
BH	BH46	B	SAMASTIPUR	BIHAR
BH	BH47	F	SARAN	BIHAR
BH	BH48	D	SINGHBHUM	BIHAR
BH	BH49	B	SITAMARHI	BIHAR
BH	BH50	B	SIWAN	BIHAR
BH	BH51	F	SUPAUL	BIHAR
BH	BH52	B	VAISHALI	BIHAR
CH	CH01	A	CHANDIGARH	CHANDIGARH
DD	DD01	A	DAMAN	DAMAN & DIU
DD	DD01	A	DIU	DAMAN & DIU
DL	DL01	B	DELHI	DELHI
DN	DN01	A	DADRA & NAGAR HAVELI	DADRA & NAGAR HAVELI
GA	GA01	C	GOA	GOA
GA	GA02	F	NORTH GOA	GOA
GA	GA03	F	SOUTH GOA	GOA
GJ	GJ01	C	AHMADABAD	GUJARAT
GJ	GJ02	C	AMRELI	GUJARAT
GJ	GJ03	C	BANAS KANTHA	GUJARAT
GJ	GJ04	C	BHARUCH	GUJARAT
GJ	GJ05	D	BHAVNAGAR	GUJARAT
GJ	GJ06	A	GANDHINAGAR	GUJARAT
GJ	GJ07	C	JAMNAGAR	GUJARAT
GJ	GJ08	D	JUNAGADH	GUJARAT
GJ	GJ09	D	KACHCHH	GUJARAT
GJ	GJ10	C	KHEDA	GUJARAT
GJ	GJ11	C	MAHESANA	GUJARAT
GJ	GJ12	C	PANCH MAHAL	GUJARAT
GJ	GJ13	D	RAJKOT	GUJARAT
GJ	GJ14	C	SABAR KANTHA	GUJARAT
GJ	GJ15	D	SURAT	GUJARAT
GJ	GJ16	C	SURENDRANAGAR	GUJARAT
GJ	GJ17	B	THE DANGS	GUJARAT
GJ	GJ18	C	VADODARA	GUJARAT
GJ	GJ19	C	VALSAD	GUJARAT
HR	HR01	C	AMBALA	HARYANA
HR	HR02	C	BHIWANI	HARYANA
HR	HR03	B	FARIDABAD	HARYANA
HR	HR04	C	GURGAON	HARYANA
HR	HR05	C	HISAR	HARYANA
HR	HR06	B	JIND	HARYANA
HR	HR07	F	KAITHAL	HARYANA
HR	HR08	C	KARNAL	HARYANA
HR	HR09	C	KURUKSHETRA	HARYANA

HR	HR10	C	MAHENDRAGARH	HARYANA
HR	HR11	F	REWARI	HARYANA
HR	HR12	B	ROHTAK	HARYANA
HR	HR13	B	SIRSA	HARYANA
HR	HR14	B	SONIPAT	HARYANA
HR	HR15	F	YAMNUNANAGAR	HARYANA
HP	HP01	B	BILASPUR	HIMACHAL PRADESH
HP	HP02	C	CHAMBA	HIMACHAL PRADESH
HP	HP03	B	HAMIRPUR	HIMACHAL PRADESH
HP	HP04	C	KANGRA	HIMACHAL PRADESH
HP	HP05	C	KINNAUR	HIMACHAL PRADESH
HP	HP06	C	KULLU	HIMACHAL PRADESH
HP	HP07	D	LAHUL & SPITI	HIMACHAL PRADESH
HP	HP08	B	MANDI	HIMACHAL PRADESH
HP	HP09	C	SHIMLA	HIMACHAL PRADESH
HP	HP10	B	SIRMAUR	HIMACHAL PRADESH
HP	HP11	B	SOLAN	HIMACHAL PRADESH
HP	HP12	B	UNA	HIMACHAL PRADESH
JK	JK01	F	ANANTNAG	JAMMU & KASHMIR
JK	JK02	F	BADGAM	JAMMU & KASHMIR
JK	JK03	F	BARAMULA	JAMMU & KASHMIR
JK	JK04	F	DODA	JAMMU & KASHMIR
JK	JK05	F	JAMMU	JAMMU & KASHMIR
JK	JK06	F	KARGIL	JAMMU & KASHMIR
JK	JK07	F	KATHUA	JAMMU & KASHMIR
JK	JK08	F	KUPWARA	JAMMU & KASHMIR
JK	JK09	F	LADAKH	JAMMU & KASHMIR
JK	JK10	F	PULWAMA	JAMMU & KASHMIR
JK	JK11	F	POONCH	JAMMU & KASHMIR
JK	JK12	F	RAJAURI	JAMMU & KASHMIR
JK	JK13	F	SRINAGAR	JAMMU & KASHMIR
JK	JK14	F	UDHAMPUR	JAMMU & KASHMIR
KN	KN01	C	BANGALORE RURAL	KARNATAKA
KN	KN02	C	BANGALORE URBAN	KARNATAKA
KN	KN03	C	BELGAUM	KARNATAKA
KN	KN04	C	BELLARY	KARNATAKA
KN	KN05	C	BIDAR	KARNATAKA
KN	KN06	C	BIJAPUR	KARNATAKA
KN	KN07	C	CHIKMAGALUR	KARNATAKA
KN	KN08	C	CHITRADURGA	KARNATAKA
KN	KN09	C	DAKSHIN KANNAD	KARNATAKA
KN	KN10	C	DHARWAD	KARNATAKA
KN	KN11	C	GULBARGA	KARNATAKA
KN	KN12	C	HASSAN	KARNATAKA
KN	KN13	C	KODAGU	KARNATAKA
KN	KN14	C	KOLAR	KARNATAKA
KN	KN15	C	MANDYA	KARNATAKA
KN	KN16	D	MYSORE	KARNATAKA
KN	KN17	D	RAICHUR	KARNATAKA
KN	KN18	C	SHIMOGA	KARNATAKA
KN	KN19	C	TUMKUR	KARNATAKA

KN	KN20	C	UTTAR KANNAD	KARNATAKA
KR	KR01	B	ALAPPUZHA (ALLEPPEY)	KERALA
KR	KR02	B	KANNUR (CANNANORE)	KERALA
KR	KR03	B	ERNAKULAM	KERALA
KR	KR04	C	IDUKKI	KERALA
KR	KR05	B	KASARAGOD	KERALA
KR	KR06	B	KOTTAYAM	KERALA
KR	KR07	B	KOZHIKODE	KERALA
KR	KR08	C	MALAPPURAM	KERALA
KR	KR09	C	PALAKKAD (PALGHAT)	KERALA
KR	KR10	B	PATTANAMTITTA	KERALA
KR	KR11	B	KOLLAM (QUILON)	KERALA
KR	KR12	C	THRISSUR (TRICHUR)	KERALA
KR	KR13	B	THIRUVANANTHAPURAM (TRIVANDRUM)	KERALA
KR	KR14	B	WAYANAD	KERALA
LK	LK01	C	KAVARATTI	LAKSHADWEEP
MG	MG01	C	EAST GARO HILLS	MEGHALAYA
MG	MG02	C	EAST KHASI HILLS	MEGHALAYA
MG	MG03	B	JAINTIA HILLS	MEGHALAYA
MG	MG04	C	WEST GARO HILLS	MEGHALAYA
MG	MG05	C	WEST KHASI HILLS	MEGHALAYA
MH	MH01	B	AHMADNAGAR	MAHARASHTRA
MH	MH02	C	AKOLA	MAHARASHTRA
MH	MH03	B	AMRAVATI	MAHARASHTRA
MH	MH04	C	AURANGABAD	MAHARASHTRA
MH	MH05	C	BHANDARA	MAHARASHTRA
MH	MH06	C	BID	MAHARASHTRA
MH	MH07	A	BOMBAY CITY	MAHARASHTRA
MH	MH08	B	BOMBAY SUBURBAN	MAHARASHTRA
MH	MH09	B	BULDANA	MAHARASHTRA
MH	MH10	B	CHANDRAPUR	MAHARASHTRA
MH	MH11	C	DHULE	MAHARASHTRA
MH	MH12	C	GARHCHIROLI	MAHARASHTRA
MH	MH13	C	JALGAON	MAHARASHTRA
MH	MH14	C	JALNA	MAHARASHTRA
MH	MH15	C	KOLHAPUR	MAHARASHTRA
MH	MH16	C	LATUR	MAHARASHTRA
MH	MH17	C	NAGPUR	MAHARASHTRA
MH	MH18	B	NANDED	MAHARASHTRA
MH	MH19	B	NASHIK	MAHARASHTRA
MH	MH20	C	OSMANABAD	MAHARASHTRA
MH	MH21	C	PARBHANI	MAHARASHTRA
MH	MH22	C	PUNE	MAHARASHTRA
MH	MH23	B	RATNAGIRI	MAHARASHTRA
MH	MH24	C	RAYGAD	MAHARASHTRA
MH	MH25	C	SANGLI	MAHARASHTRA
MH	MH26	C	SATARA	MAHARASHTRA
MH	MH27	C	SINDHUDURG	MAHARASHTRA
MH	MH28	B	SOLAPUR	MAHARASHTRA

MH	MH29	C	THANE	MAHARASHTRA
MH	MH30	C	WARDHA	MAHARASHTRA
MH	MH31	B	YAVATMAL	MAHARASHTRA
MN	MN01	B	BISHNUPUR	MANIPUR
MN	MN02	B	CHANDEL	MANIPUR
MN	MN03	C	CHURACHANDPUR	MANIPUR
MN	MN04	C	IMPHAL	MANIPUR
MN	MN05	C	SENAPATI	MANIPUR
MN	MN06	C	TAMENGLONG	MANIPUR
MN	MN07	B	THOUBAL	MANIPUR
MN	MN08	C	UKHRUL	MANIPUR
MP	MP01	F	BADWANI	MADHYA PRADESH
MP	MP02	C	BALAGHAT	MADHYA PRADESH
MP	MP03	D	BASTAR	MADHYA PRADESH
MP	MP04	C	BETUL	MADHYA PRADESH
MP	MP05	C	BHIND	MADHYA PRADESH
MP	MP06	C	BHOPAL	MADHYA PRADESH
MP	MP07	D	BILASPUR	MADHYA PRADESH
MP	MP08	C	CHHATARPUR	MADHYA PRADESH
MP	MP09	C	CHHINDWARA	MADHYA PRADESH
MP	MP10	C	DAMOH	MADHYA PRADESH
MP	MP11	F	DANTEWARA	MADHYA PRADESH
MP	MP12	C	DATIA	MADHYA PRADESH
MP	MP13	C	DEWAS	MADHYA PRADESH
MP	MP14	F	DHAMTHARE	MADHYA PRADESH
MP	MP15	C	DHAR	MADHYA PRADESH
MP	MP16	F	DINDORI	MADHYA PRADESH
MP	MP17	D	DURG	MADHYA PRADESH
MP	MP18	C	EAST NIMAR	MADHYA PRADESH
MP	MP19	C	GUNA	MADHYA PRADESH
MP	MP20	C	GWALIOR	MADHYA PRADESH
MP	MP21	F	HARDA	MADHYA PRADESH
MP	MP22	D	HOSHANGABAD	MADHYA PRADESH
MP	MP23	B	INDORE	MADHYA PRADESH
MP	MP24	D	JABALPUR	MADHYA PRADESH
MP	MP25	A	JALAUN	MADHYA PRADESH
MP	MP26	F	JANJGIR	MADHYA PRADESH
MP	MP27	F	JASHPURNAGAR	MADHYA PRADESH
MP	MP28	C	JHABUA	MADHYA PRADESH
MP	MP29	F	KANKER	MADHYA PRADESH
MP	MP30	F	KATNI	MADHYA PRADESH
MP	MP31	F	KAWARDHA	MADHYA PRADESH
MP	MP32	F	KORBA	MADHYA PRADESH
MP	MP33	F	MAHASAMUNDA	MADHYA PRADESH
MP	MP34	B	MANDLA	MADHYA PRADESH
MP	MP35	C	MANDSAUR	MADHYA PRADESH
MP	MP36	D	MORENA	MADHYA PRADESH
MP	MP37	C	NARSIMHAPUR	MADHYA PRADESH
MP	MP38	F	NIMACH	MADHYA PRADESH
MP	MP39	C	PANNA	MADHYA PRADESH

MP	MP40	D	RAIGARH	MADHYA PRADESH
MP	MP41	D	RAIPUR	MADHYA PRADESH
MP	MP42	C	RAISEN	MADHYA PRADESH
MP	MP43	B	RAJ NANDGAON	MADHYA PRADESH
MP	MP44	C	RAJGARH	MADHYA PRADESH
MP	MP45	C	RATLAM	MADHYA PRADESH
MP	MP46	C	REWA	MADHYA PRADESH
MP	MP47	C	SAGAR	MADHYA PRADESH
MP	MP48	C	SATNA	MADHYA PRADESH
MP	MP49	C	SEHORE	MADHYA PRADESH
MP	MP50	C	SEONI	MADHYA PRADESH
MP	MP51	D	SHAHDOL	MADHYA PRADESH
MP	MP52	C	SHAJAPUR	MADHYA PRADESH
MP	MP53	C	SHIVPURI	MADHYA PRADESH
MP	MP54	F	SHYONPUR-KALAN	MADHYA PRADESH
MP	MP55	C	SIDHI	MADHYA PRADESH
MP	MP56	D	SURGUJA	MADHYA PRADESH
MP	MP57	C	TIKAMGARH	MADHYA PRADESH
MP	MP58	C	UJJAIN	MADHYA PRADESH
MP	MP59	F	UMJHIA	MADHYA PRADESH
MP	MP60	C	VIDISHA	MADHYA PRADESH
MP	MP61	C	WEST NIMAR	MADHYA PRADESH
MZ	MZ01	C	AIZWAL	MIZORAM
MZ	MZ02	C	CHHIMTUIPUI	MIZORAM
MZ	MZ03	C	LUNGLEI	MIZORAM
NG	NG01	C	KOHIMA	NAGALAND
NG	NG02	B	MOKOKCHUNG	NAGALAND
NG	NG03	B	MON	NAGALAND
NG	NG04	B	PHEK	NAGALAND
NG	NG05	C	TUENSANG	NAGALAND
NG	NG06	B	WOKHA	NAGALAND
NG	NG07	B	ZUNHEBOTO	NAGALAND
OR	OR01	F	ANGUL	ORISSA
OR	OR02	C	BALANGIR	ORISSA
OR	OR03	C	BALESHWAR	ORISSA
OR	OR04	F	BARUGARH	ORISSA
OR	OR05	F	BHADRAKH	ORISSA
OR	OR06	F	BOUDH (PHULBANI)	ORISSA
OR	OR07	C	CUTTACK	ORISSA
OR	OR08	F	DEOGADA (SAMBALPUR)	ORISSA
OR	OR09	D	DHENKANAL	ORISSA
OR	OR10	C	GANJAM	ORISSA
OR	OR11	F	GAJAPATI	ORISSA
OR	OR12	F	JAGATSINGHPUR	ORISSA
OR	OR13	D	KALAHANDI	ORISSA
OR	OR14	C	KENDUJHAR	ORISSA
OR	OR15	F	KENDRAPARA	ORISSA
OR	OR16	F	KHURDA	ORISSA
OR	OR17	D	KORAPUT	ORISSA
OR	OR18	F	MALKANAGIRI	ORISSA
OR	OR19	C	MAYURBHANJ	ORISSA

OR	OR20	F	MAYURGARH	ORISSA
OR	OR21	F	NABARANGPUR	ORISSA
OR	OR22	F	NUAPADA	ORISSA
OR	OR23	C	PHULABANI	ORISSA
OR	OR24	D	PURI	ORISSA
OR	OR25	F	RAYAGUDA	ORISSA
OR	OR26	C	SAMBALPUR	ORISSA
OR	OR27	F	SONPUR	ORISSA
OR	OR28	D	SUNDARGARH	ORISSA
OR	OR29	F	TAJPUR	ORISSA
OR	OR30	F	THARSUGUDA (SAMBALPUR)	ORISSA
PC	PC01	A	KARAIKAL	PONDICHERRY
PC	PC02	F	MAHE	PONDICHERRY
PC	PC03	A	PONDICHERRY	PONDICHERRY
PC	PC04	F	YANAM	PONDICHERRY
PN	PN01	C	AMRITSAR	PUNJAB
PN	PN02	C	BATHINDA	PUNJAB
PN	PN03	C	FARIDKOT	PUNJAB
PN	PN04	F	FATEHGARH SAHIB	PUNJAB
PN	PN05	C	FIROZPUR	PUNJAB
PN	PN06	C	GURDASPUR	PUNJAB
PN	PN07	C	HOSHIARPUR	PUNJAB
PN	PN08	C	JALANDHAR	PUNJAB
PN	PN09	C	KAPURTHALA	PUNJAB
PN	PN10	C	LUDHIANA	PUNJAB
PN	PN11	F	MANSA	PUNJAB
PN	PN12	C	PATIALA	PUNJAB
PN	PN13	F	ROPAR	PUNJAB
PN	PN14	C	RUPNAGAR	PUNJAB
PN	PN15	C	SANGRUR	PUNJAB
RJ	RJ01	C	AJMER	RAJASTHAN
RJ	RJ02	C	ALWAR	RAJASTHAN
RJ	RJ03	C	BANSWARA	RAJASTHAN
RJ	RJ04	F	BARAN	RAJASTHAN
RJ	RJ05	D	BARMER	RAJASTHAN
RJ	RJ06	C	BHARATPUR	RAJASTHAN
RJ	RJ07	C	BHILWARA	RAJASTHAN
RJ	RJ08	D	BIKANER	RAJASTHAN
RJ	RJ09	C	BUNDI	RAJASTHAN
RJ	RJ10	D	CHITTAURGARH	RAJASTHAN
RJ	RJ11	C	CHURU	RAJASTHAN
RJ	RJ12	F	DAUSA	RAJASTHAN
RJ	RJ13	C	DHAULPUR	RAJASTHAN
RJ	RJ14	C	DUNGARPUR	RAJASTHAN
RJ	RJ15	D	GANGANAGAR	RAJASTHAN
RJ	RJ16	D	JAIPUR	RAJASTHAN
RJ	RJ17	D	JAISALMER	RAJASTHAN
RJ	RJ18	C	JALOR	RAJASTHAN
RJ	RJ19	C	JHALAWAR	RAJASTHAN
RJ	RJ20	B	JHUNJHUNUN	RAJASTHAN
RJ	RJ21	D	JODHPUR	RAJASTHAN
RJ	RJ22	C	KOTA	RAJASTHAN

RJ	RJ22	C	KOTA	RAJASTHAN
RJ	RJ23	D	NAGAUR	RAJASTHAN
RJ	RJ24	D	PALI	RAJASTHAN
RJ	RJ25	F	RAJ SAMAND (UDAIPUR)	RAJASTHAN
RJ	RJ26	C	SAWAI MADHOPUR	RAJASTHAN
RJ	RJ27	C	SIKAR	RAJASTHAN
RJ	RJ28	C	SIROHI	RAJASTHAN
RJ	RJ29	C	TONK	RAJASTHAN
RJ	RJ30	D	UDAIPUR	RAJASTHAN
SK	SK01	B	EAST	SIKKIM
SK	SK02	A	NORTH	SIKKIM
SK	SK03	B	SOUTH	SIKKIM
SK	SK04	B	WEST	SIKKIM
TN	TN01	C	ANNA	TAMIL NADU
TN	TN02	C	CHENGAI-MGR (CHENGALPATTU)	TAMIL NADU
TN	TN03	C	CHIDAMBARANAR	TAMIL NADU
TN	TN04	C	COIMBATORE	TAMIL NADU
TN	TN05	C	DHARMAPURI	TAMIL NADU
TN	TN06	C	KAMARAJAR	TAMIL NADU
TN	TN07	B	KANNIYAKUMARI	TAMIL NADU
TN	TN08	A	MADRAS	TAMIL NADU
TN	TN09	C	MADURAI	TAMIL NADU
TN	TN10	F	NAGAPATTINAM-QUAID E MILLAT	TAMIL NADU
TN	TN11	B	NILGIRI	TAMIL NADU
TN	TN12	C	NORTH ARCOT-AMBEDKAR	TAMIL NADU
TN	TN13	C	PASUMPON MUTHURAMALINGAM	TAMIL NADU
TN	TN14	C	PERIYAR	TAMIL NADU
TN	TN15	C	PUDUKKOTTAI	TAMIL NADU
TN	TN16	C	RAMANATHAPURAM	TAMIL NADU
TN	TN17	C	SALEM	TAMIL NADU
TN	TN18	C	SOUTH ARCOT	TAMIL NADU
TN	TN19	C	THANJAVUR	TAMIL NADU
TN	TN20	B	TIRUCHIRAPPALLI	TAMIL NADU
TN	TN21	C	TIRUNELVELI KATTABOMMAN	TAMIL NADU
TN	TN22	F	THIRUVANNAMALAI SAMBUVARAYAR	TAMIL NADU
TN	TN23	F	VILLUPURAM RAMASAMY PADAYACHI	TAMIL NADU
TR	TR01	C	NORTH TRIPURA	TRIPURA
TR	TR02	C	SOUTH TRIPURA	TRIPURA
TR	TR03	C	WEST TRIPURA	TRIPURA
UP	UP01	C	AGRA	UTTAR PRADESH
UP	UP02	C	ALIGARH	UTTAR PRADESH
UP	UP03	C	ALLAHABAD	UTTAR PRADESH
UP	UP04	C	ALMORA	UTTAR PRADESH
UP	UP05	B	AZAMGARH	UTTAR PRADESH
UP	UP06	C	BADAUN	UTTAR PRADESH
UP	UP07	C	BAHRAICH	UTTAR PRADESH
UP	UP08	B	BALLIA	UTTAR PRADESH
UP	UP09	C	BANDA	UTTAR PRADESH
UP	UP10	B	BARA BANKI	UTTAR PRADESH

UP	UP11	C	BAREILLY	UTTAR PRADESH
UP	UP12	C	BASTI	UTTAR PRADESH
UP	UP13	B	BIJNOR	UTTAR PRADESH
UP	UP14	C	BULANDSHAHR	UTTAR PRADESH
UP	UP15	C	CHAMOLI	UTTAR PRADESH
UP	UP16	C	DEHRA DUN	UTTAR PRADESH
UP	UP17	C	DEORIA	UTTAR PRADESH
UP	UP18	C	ETAH	UTTAR PRADESH
UP	UP19	C	ETAWAH	UTTAR PRADESH
UP	UP20	C	FAIZABAD	UTTAR PRADESH
UP	UP21	C	FARRUKHABAD	UTTAR PRADESH
UP	UP22	C	FATEHPUR	UTTAR PRADESH
UP	UP23	B	FIROZABAD	UTTAR PRADESH
UP	UP24	C	GARHWAL	UTTAR PRADESH
UP	UP25	C	GHAZIABAD	UTTAR PRADESH
UP	UP26	B	GHAZIPUR	UTTAR PRADESH
UP	UP27	C	GONDA	UTTAR PRADESH
UP	UP28	C	GORAKHPUR	UTTAR PRADESH
UP	UP29	C	HAMIRPUR	UTTAR PRADESH
UP	UP30	C	HARDOI	UTTAR PRADESH
UP	UP31	B	HARIDWAR	UTTAR PRADESH
UP	UP32	C	JALAUN	UTTAR PRADESH
UP	UP33	B	JAUNPUR	UTTAR PRADESH
UP	UP34	C	JHANSI	UTTAR PRADESH
UP	UP35	C	KANPUR DEHAT	UTTAR PRADESH
UP	UP36	B	KANPUR NAGAR	UTTAR PRADESH
UP	UP37	B	KHERI	UTTAR PRADESH
UP	UP38	B	LALITPUR	UTTAR PRADESH
UP	UP39	B	LUCKNOW	UTTAR PRADESH
UP	UP40	F	MAHARAJGANJ	UTTAR PRADESH
UP	UP41	C	MAINPURI	UTTAR PRADESH
UP	UP42	B	MATHURA	UTTAR PRADESH
UP	UP43	B	MAU	UTTAR PRADESH
UP	UP44	F	MAUNATH BHANJAN	UTTAR PRADESH
UP	UP45	C	MEERUT	UTTAR PRADESH
UP	UP46	C	MIRZAPUR	UTTAR PRADESH
UP	UP47	C	MORADABAD	UTTAR PRADESH
UP	UP48	C	MUZAFFARNAGAR	UTTAR PRADESH
UP	UP49	C	NAINI TAL	UTTAR PRADESH
UP	UP50	B	PILIBHIT	UTTAR PRADESH
UP	UP51	D	PITHORAGARH	UTTAR PRADESH
UP	UP52	C	PRATAPGARH	UTTAR PRADESH
UP	UP53	B	RAE BARELI	UTTAR PRADESH
UP	UP54	B	RAMPUR	UTTAR PRADESH
UP	UP55	B	SAHARANPUR	UTTAR PRADESH
UP	UP56	C	SHAHJAHANPUR	UTTAR PRADESH
UP	UP57	B	SIDDHARTH NAGAR	UTTAR PRADESH
UP	UP58	C	SITAPUR	UTTAR PRADESH
UP	UP59	C	SONBHADRA	UTTAR PRADESH
UP	UP60	C	SULTANPUR	UTTAR PRADESH
UP	UP61	C	TEHRI GARHWAL	UTTAR PRADESH

UP	UP62	C	UNNAO	UTTAR PRADESH
UP	UP63	C	UTTARKASHI	UTTAR PRADESH
UP	UP64	C	VARANASI	UTTAR PRADESH
WB	WB01	C	BANKURA	WEST BENGAL
WB	WB02	C	BARDDHAMAN	WEST BENGAL
WB	WB03	C	BIRBHUM	WEST BENGAL
WB	WB04	A	CALCUTTA	WEST BENGAL
WB	WB05	B	DARJEELING	WEST BENGAL
WB	WB06	B	HAORA	WEST BENGAL
WB	WB07	C	HUGLI	WEST BENGAL
WB	WB08	C	JALPAIGURI	WEST BENGAL
WB	WB09	C	KOCHBIHAR	WEST BENGAL
WB	WB10	C	MALDAH	WEST BENGAL
WB	WB11	C	MEDINIPUR	WEST BENGAL
WB	WB12	C	MURSHIDABAD	WEST BENGAL
WB	WB13	C	NADIA	WEST BENGAL
WB	WB14	D	NORTH 24 PARGANAS	WEST BENGAL
WB	WB15	C	PURULIYA	WEST BENGAL
WB	WB16	A	SOUTH 24 PARGANAS	WEST BENGAL
WB	WB17	C	WEST DINAJPUR	WEST BENGAL

F - Boundary not available

III ACRONYMS

ACCEPTS	Access Expert System
AC	Alternate Current
ACCT	Ancillary Computer Compatible Tape
A/D	Analogue to Digital
AOCS	Attitude and Orbit Control System
AOS	Acquisition of Signal
AH	Amphere Hour
AVHRR	Advanced Very High Resolution Radiometer
AZ	Azimuth
BCD	Binary Coded Decimal
BCH	Bose-Chaudhury-Hocquenhem
BPS	Browse Processing System
BIL	Band Interleaved by Line
BPSK	Bi-phase Phase Shift Keying
BPS	Browse Processing System
BSQ	Band Sequential
BSSC	Bit Synchroniser and Signal Condi tioner
B/H	Base/Height
B/W	Black & White
CALD	Calibration Data file in UCCT
CAL	Calibration
CALCCT	Calibration CCT
CB	Colour Balance
CC	Cubic Convolution
CCD	Charge Coupled Device
CCT	Computer Compatible Tape
CFRP	Carbon Fibre Reinforced Plastic
CLUT	Common Look-Up-Table
CTs	Cartridges
DAT	Digital Audio Tape
DB	Database
DBS	Digital Browsing System
DC	Direct Current
DECnet	Digital Electronics Cooperation network
DMCR	Dedicated Mission Control Room
DN	Digital Number
DOS	Department Of Space
DPS	Data Processing System
DTM	Digital Terrain Model
DQE	Data Quality Evaluation
DRS	Data Reception Station
dB	Decible
dBm	Decible-milliwatt
dBw	Decible-watt
deg	Degrees
ECL	Emitter Coupled Logic
EIRP	Effective Isotropic Radiative Power
EL	Elevation
EM	Electro Magnetic (Spectrum)
EOM	Electro Optic Module
EOF	End-Of-File
EOL	End-Of-Line
EOSAT	Earth Observation Satellite Company
EQLUT	Equatorial Look Up Table
ERS	European Remote Sensing Satellite
FCC	False Color Composite
FDRS	Foreign Data Receiving Station
Flps	Floppies
FM	Frequency Modulation
FSKM	Frequency Shift Key Modulation
FSC	Frame Sync Code
GCP	Ground Control Point
GDQE	Geometric Data Quality Evaluation
GPS	Global Positioning System
G/T	Gain/NoiseTemperature
GMT	Greenwich Meridian Time
HDT	High Density Digital Tape
HDTR	High Density Tape Recorder
HK	House Keeping
HLUT	Histogram Look Up Table
HP	Horse Power
Hz	Hertz
IMGY	Image data file in UCCT
IMS	Information Management System
IIMS	Integrated Information Management System

IMSD	Integrated Mission for Sustainable Development
IPC	In Process Control
IPS	Inches per second
IR	Infrared
IRS	Indian Remote Sensing Satellite
ISAC	ISRO Satellite Centre
ISRO	Indian Space Research Organisation
IST	Indian Standard Time
ISTRAC	ISRO Telemetry, Tracking and Command Network
JPEG	Joint Photographic Experimental Groups
KB	KiloBits
KBPI	KiloBits Per Inch
KHz	Kilo Hertz
Km	Kilometre
Lat	Latitude
LCC	Lambert's Conformal Conical
LBT	Low Bit Telemetry
LCC	Lambert's Conformal Conic projection
LFFR	Large Format Film Recorder
LED	Light Emitting Diode
LGSOWG	Landsat Ground Station Operators Working Group
LISS	Linear Imaging and Self Scanning
LOS	Loss of Signal
LSB	Least Significant Bit
LTC	Light Transfer Characteristics
LUT	Look-up Table
Long	Longtitude
MB	Megabytes
MBPS	Megabits Per Second
MCC	Mission Control Centre
MFPH	Multimission Front and Processing Hardware
MHz	Mega Hertz
MLA	Multi Spectral Array
MOS	Modular Opto elctronic Scanner
MSB	Most Significant Bit
MSS	Multi Spectral Scanner
ms	millisecond
MTF	Modulation Transfer Function
mw	milli watts
N	Newton
ND	Neutral Density
NB	Narrow Band
NDC	NRSA Data Centre
NIR	Near Infra Red
NOAA	National Oceanic Atmospheric Administration
NN	Nearest Neighbour
NNRMS	National Natural Resources Management System
NRSA	National Remote Sensing Agency
OBTR	On Board Tape Recorder
OSR	Optical Solar Reflectors
PAN	Panchromatic
PC	Personal Computer
PCT	Photo Compatible Tape
PCM	Pulse Code Modulation
PLA	Panchromatic Linear Array
PM	Phase Modulation
POL	Polyconic Projection
PR	Programming Request
PS	Polar Stereographic projection
PSK	Phase Shift Keying
PSLV	Polar Satellite Launch Vehicle
PSM	Payload Steering Mechanism
PT	Processed Tape
QAS	Quality Assurance System
QC	Quality Control
QL	Quick Look
QPSK	Quadrature Phase Shift Keying
RCS	Reaction Contol System
RDQE	Radiomatric Data Quality Evaluation
RF	Radio Frequency
RHC	Right Hand Circular
RMS	Root Mean Square
RNRZ (L)	Randomised Non-return to Zero (Level)
RNRZ (S)	Randomised Non-return to Zero (Space)
RPM	Rotations per Minute

RRSSC	Regional Remote Sensing Service Centre	TCG	Time Code Generator
		TRAI	Trailer file in UCCT
RSS	Root Sum Square	TIU	Telemetry Interface Unit
RST	Raw Star Sensor	TM	Telemetry
SAC	Space Application Centre	TM	Thematic Mapper
SAT	Shift Along Track	TTC	Telemetry Tracking and Command
S/C	Space Craft	TV	Television
SCC	Spacecraft Control Centre	TWTA	Travelling Wave Tube Amplifier
SCR	Silicon Controlled Rectifier	UT	Universal Time
SNR	Signal-to-noise Ratio	UTM	Universal Transverse Mercator projection
SOM	Space Oblique Mercator Projection		
SOI	Survey of India	UCCT	User Computer Compatible Tape
SPOT	Systeme Pour l' Observation de la Terre	V	Visible
		VAX	Virtual Address Extension
SWIR	Short Wave Infra Red	VIM	Vegetation Index Map
SWR	Square Wave Response	WB	Wide Band
TC	Telecommand	WiFS	Wide Field Sensor