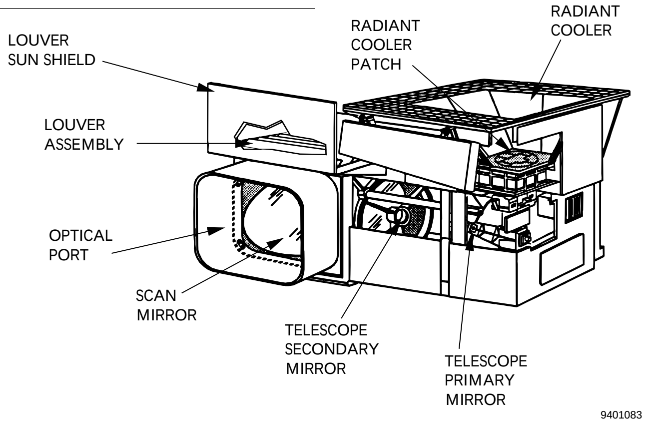
Imager

The GOES I-M Imager is a five-channel (one visible, four infrared) imaging radiometer designed to sense radiant and solar reflected energy from sampled areas of the earth. By means of a servo-driven, two-axis gimballed mirror scan system in conjunction with a Cassegrain telescope, the Imager's multispectral channels can simultaneously sweep an 8-kilometer (5-statute mile) north-to-south swath along an east-to-west / west-to-east path, at a rate of 20° (optical) east-west per second.

Imager Instrument Characteristics

Channel	Detector Type	Nominal square IGFOV at nadir
1 (Visible)	Silicon	1 km
2 (Shortwave)	InSb	4 km
3 (Moisture)	HgCdTe	8 km
4 (Longwave 1)	HgCdTe	4 km
5 (Longwave 2)	HgCdTe	4 km

Parameter	Performance
FOV defining element	Detector
Channel-to-channel alignment	28 µrad (1.0 km) at nadir
Radiometric calibration	300 K internal blackbody and space view
Signal quantizing	10 bits, all channels
Scan capability	Full earth, sector, area
Output data rate	2,620,800 b / s
Imaging areas	20.8° E / W by 19° N / S



Imaging Channels Allocation

Channel Number	**Wavelength Range (µm)**	**Range of Measurement**	**Meteorological Objective and Maximum Temperature Range**
1	0.55 to 0.75	1.6 to 100% albedo	Cloud cover
2 (GOES-I/J/K)	3.80 to 4.00	4 to 320 K	Nighttime clouds (space – 340 K)
2 (GOES-L/M)	3.80 to 4.00	4 to 335 K	Nighttime clouds (space – 340 K)
3 (GOES-I/J/K/L)	6.50 to 7.00	4 to 320 K	Water vapor (space – 290 K)
3 (GOES-M)	13.0 to 13.7	4 to 320 K	Cloud cover and height
4	10.20 to 11.20	4 to 320 K	Sea surface temperature and water vapor (space – 335 K)
5 (GOES-I/J/K/L)	11.50 to 12.50	4 to 320 K	Sea surface temperature and water vapor (space – 335 K)
5 (GOES-M)	5.8 to 7.3	4 to 320 K	Water vapor

Imager Performance Summary

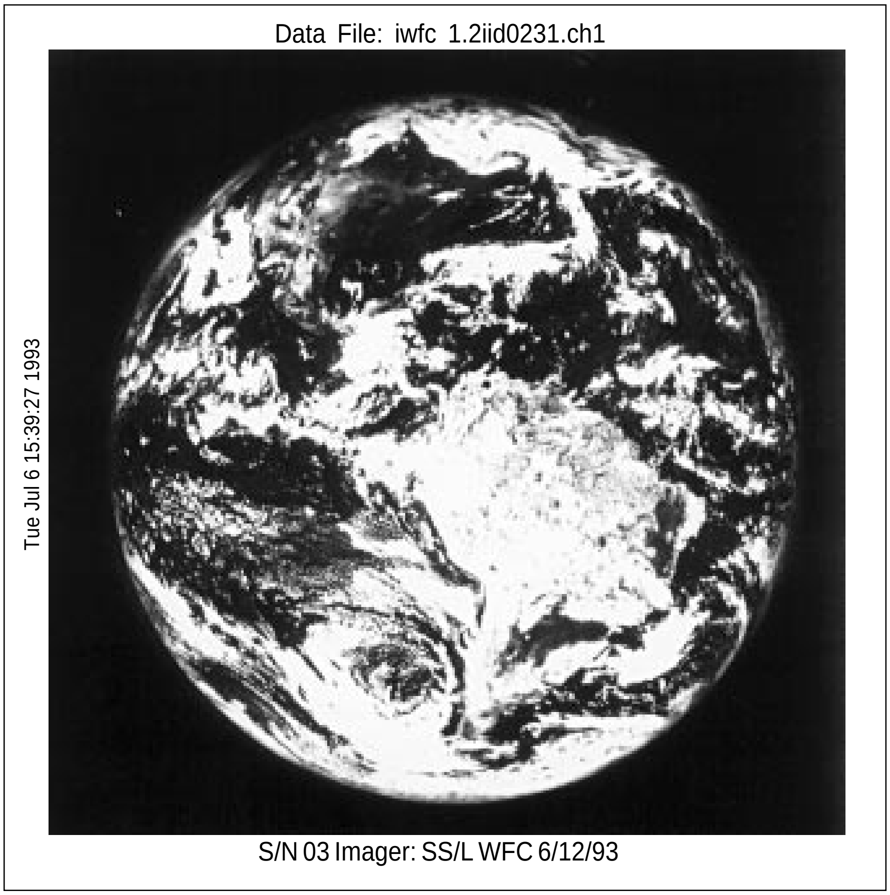
Parameter	**Performance**		
System absolute accuracy	Infrared channel ≤1 K Visible channel ±5% of maximum scene radiance		
System relative accuracy	Line to line	≤0.1 K	
	Detector to detector	≤0.2 K	
	Channel to channel	≤0.2 K	
	Blackbody calibration to calibration	≤0.35 K	
Star sense area	21° N/S by 23° E/W		
Imaging rate	Full earth ≤26 min		
Time delay	≤3 min		
Fixed Earth projection and grid duration	24 hours		
Data timeliness			
Spacecraft processing	≤30 s		
Data coincidence	≤5 s		
Imaging periods		*Noon ±8 Hours*	*Midnight ±4 Hours*
Image navigation accuracy at nadir		4 km	6 km
Registration within an image*	25 min	50 µrad	50 µrad
Registration between repeated images*	15 min	53 µrad	70 µrad
	90 min	84 µrad	105 µrad
	24 h	168 µrad	168 µrad
* For spec orbit	48 h	210 µrad	210 µrad
Channel-to-channel registration		28 µrad	28 µrad (IR only)

Wide Field Earth Target

Wide Field Collimator Test

Because the Earth subtends a very wide angle as seen from the operational GOES spacecraft, simulating on-orbit conditions in the laboratory for test purposes presents a special challenge to the test designers. The usual test source would be a standard collimator placed in front of the instrument being tested and capable of simulating only a small portion of an accurately sized image. Though much useful information can be obtained by this method, it has long been desired to simulate the entire scene that an instrument would observe from geostationary orbit.

Image of Earth Target from S/N 03 Imager



The wide field collimator provides such a “flight like” scene by utilizing a very wide field lens (~18 degrees) originally designed for use with an aerial reconnaissance camera. The collimator projects a high quality image of the Earth, obtained from an actual satellite photograph, through the wide field lens, producing the correct angular extent as viewed from geostationary orbit. The imager then forms an image of the Earth scene as it would while operating in space. A comparison of the resulting image with the original verifies the Imager’s performance. This method yields a simple end-to-end test that relies on the fewest number of assumptions.

The Subsystem

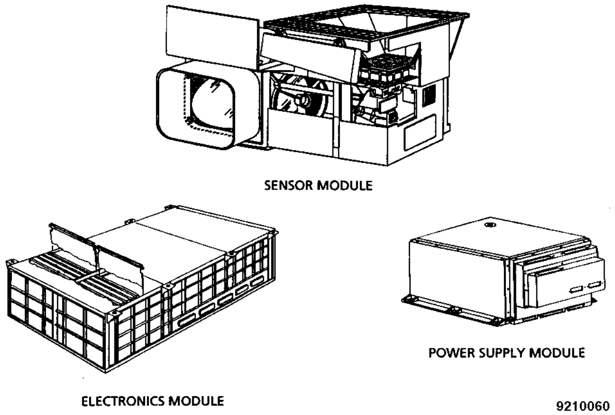
The Imager consists of electronics, power supply, and sensor modules. The sensor module, containing the telescope, scan assembly, and detectors, is mounted on a baseplate external to the spacecraft, together with the shields and louvers for thermal control. The electronics module provides redundant circuitry and performs command, control, and signal processing functions; it also serves as a structure for mounting and interconnecting the electronic boards for proper heat dissipation. The power supply module contains the converters, fuses, and power control for interfacing with the spacecraft electrical power subsystem. The electronics and power supply modules are mounted on the spacecraft internal equipment panel.

Signal flow through the Imager maintains the maximum capability of each part of the optical, detection, and electronic subsystems in order to preserve the quality and accuracy of the sensed information. The scene radiance, collected by the Imager's optical system, is separated into appropriate spectral channels by beam splitters that also route the signal to various infrared (IR) detector sets where they are imaged onto the respective detectors for each channel. Each detector converts the scene radiance into an electrical signal that is amplified, filtered, and digitized; the resulting digital signal is routed to a sensor data transmitter, then to an output multiplexer for downlinking to a ground station.

A user may request one or a set of images that start at a selected latitude and longitude (or lines and pixels) and end at another latitude and longitude (or lines and pixels). The Imager responds to scan locations that correspond to those command inputs. The image frame may include the entire earth's disk or any portion of it and the frame may begin at any time. Scan control is not limited in scan size or time; an entire viewing angle of 21° north/south (N/S) by 23° east/west (E/W) is available for star sensing. Imaging limits are 19° N/S by 20.8° E/W. Requests for up to 63 repeats of a given image can be made by ground command. A frame sequence can be interrupted for "priority" scans; the system will scan a priority frame set or star sense, then automatically return to the original set.

Infrared radiometric quality is maintained by frequent and timed interval views (2.2, 9.2, or 36.6 seconds, ground command selectable) of space for reference. Less frequent views of the full-aperture internal blackbody establishes a high-temperature baseline for calibration in orbit. Via ground command or automatically, repeat of this calibration every 10 minutes is more than adequate to maintain accuracy of the output data under the worst conditions of time and temperature. In addition to radiometric calibration, the amplifiers and data stream are checked regularly by an internal staircase signal to verify stability and linearity of the output data.

Imager Modules



Operation

The Imager is controlled via a defined set of command inputs. Position and size of an area scan are controlled by command, so the instrument is capable of full-earth imagery (19° N/S by 20.8° E/W), sector imagery that contains the edges of the earth's disk, and various area scan sizes totally enclosed within the earth scene. However, the maximum scan width processed by the operations ground equipment is 19.2°. Area scan selection permits continuous, rapid viewing of local areas for accurate wind determination and monitoring mesoscale phenomena. Area scan size and location are definable to less than one visible pixel, yielding complete flexibility.

The Imager's flexibility of operation also provides a star sensing capability (as dim as B0-class fourth magnitude). Once the time and location of a star is predicted, the Imager is pointed to that location within its 21° N/S by 23° E/W field of view (FOV) and the scan stopped. As the star image passes through the 1- by 8-kilometer visible array, it is sampled at a rate of 21,817 samples per second. The star sense sensitivity is enhanced by increasing the electronic gain and reducing the noise bandwidth of the visible preamplifiers, permitting sensing of a sufficient number of stars for image navigation and registration purposes.

By virtue of its digitally controlled scanner, the Imager provides operational imaging from full earth scan to mesoscale area scans. Accuracy of location is provided by the absolute position control system, in which position error is noncumulative. Within the instrument, each position is defined precisely and any chosen location can be reached and held to a high accuracy. This registration accuracy is maintained along a scan line, throughout an image and over time. Total system accuracies relating to spacecraft motion and attitude determination also include this allocated error.

Motion of the Imager and Sounder scan mirrors causes a small but well-defined disturbance of spacecraft attitude, which is gradually reduced by spacecraft control but at a rate too slow to be totally compensated. Since all physical factors of the scanners and spacecraft are known and scan positions are continuously provided by the Imager and Sounder, the disturbances caused by each scan motion on the spacecraft are easily calculated by the attitude and orbit control subsystem (AOCS). A compensating signal is developed and applied in the scan servo-control loop to bias scanning and offset the disturbance. This simple signal and control interface provides corrections that minimize any combination of effects. With this technique, the Imager and Sounder are totally independent, maintaining image location accuracy regardless of the other unit's operational status. If needed, this mirror motion compensation scheme can be disabled by command.

The AOCS also provides compensation signals that counteract spacecraft attitude, orbital effects, and predictable structural-thermal effects within the spacecraft-instrument combination. These effects are used to fit parameters for a 24 hour period during which they are used to predict disturbances. Ground-developed corrective algorithms are fed to the instruments via the AOCS as a total image motion compensation (IMC) signal that includes the mirror motion compensation described above.

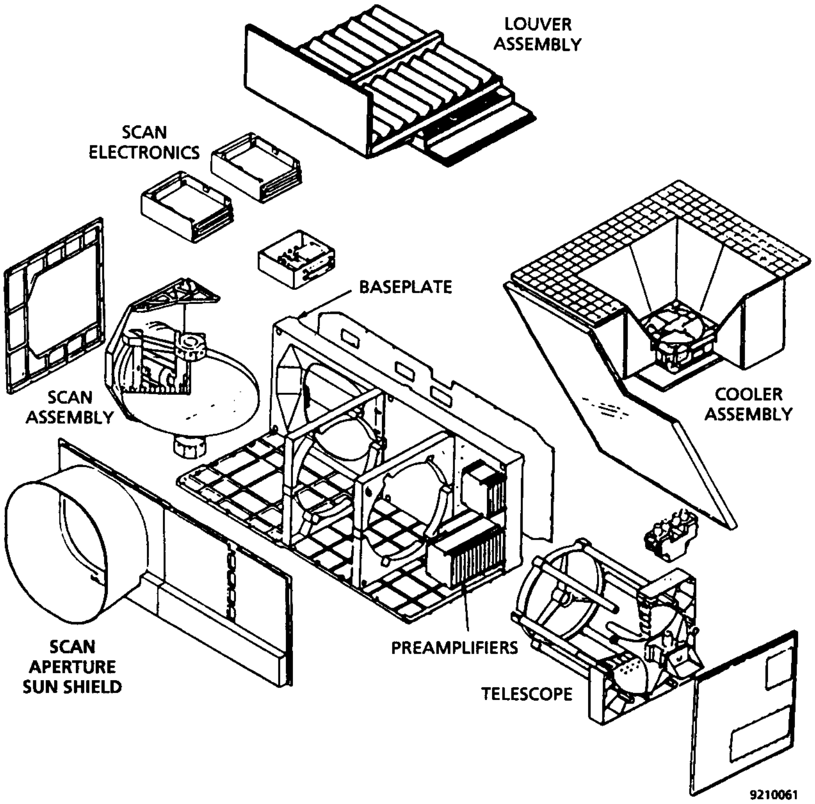
Sensor Module

The sensor module consists of a cooler assembly, telescope, aft optics, preamplifiers, scan aperture sunshield, scan assembly, baseplate, scan electronics, and louver assembly. The baseplate becomes the optical bench to which the scan assembly and telescope are mounted. A passive louver assembly and electrical heaters on the base aid thermal stability of the telescope and major components. A passive radiant cooler with a thermostatically controlled heater maintains the IR detectors at 94 K during the 6 months of winter solstice season and then at 101 K for the remainder of the year for efficient operation. A backup temperature of 104 K is also provided. The visible detectors are at instrument temperature of 13 to 30 °C. The preamplifiers convert the low-level signals to higher-level, low-impedance outputs for transmission by cable to the electronics module.

Imager Optics

To gather emitted or reflected energy, the scanner moves a flat mirror to produce a bidirectional raster scan. Thermal emissions and reflected sunlight from the scene pass through a scan aperture protected by a sun shield, then the precision flat mirror deflects them into a reflective telescope. The telescope, a Cassegrain type with a 31.1-centimeter (12.2-inch) diameter primary mirror, concentrates the energy onto a 5.3-centimeter (2.1-inch) diameter secondary mirror. The surface shape of this mirror forms a long focal length beam that passes the energy to the detectors via relay optics.

Expanded View of Sensor Module

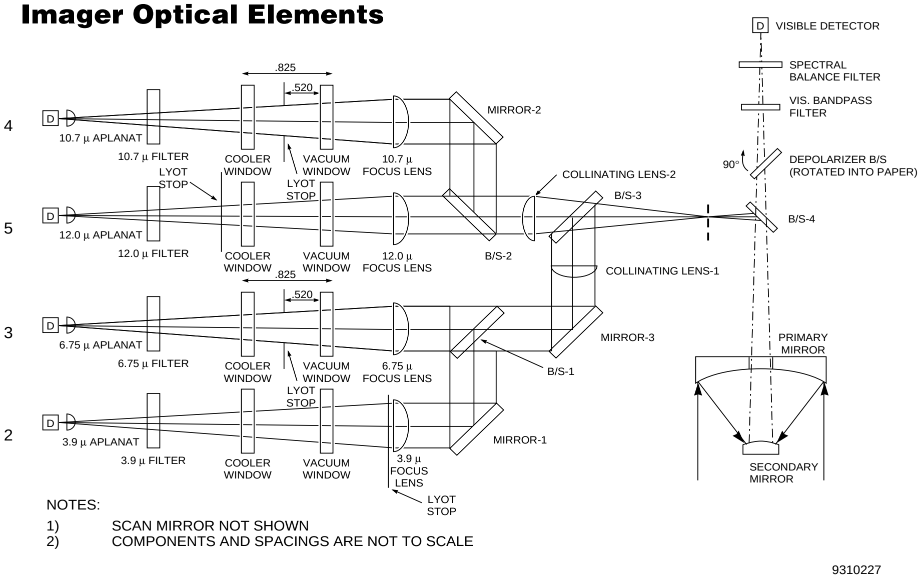


Dichroic beamsplitters (B/Ss) separate the scene radiance into the spectral bands of interest. The IR energy is deflected to the detectors within the radiative cooler, while the visible energy passes through the dichroic beamsplitters and is focused on the visible detector elements. The IR energy is separated into the 3.9, 6.75, 10.7, and 12 µm channels. These four beams are directed into the radiant cooler, where the spectral channels are defined by cold filters. Each of the four IR channels has a set of detectors defining the field size and shape.

Optical performance is maintained by restricting the sensor module total temperature range, and radiometric performance is maintained by limiting the temperature change between views of cold space (rate of change of temperature). Thermal control also contributes to channel registration and focus stability. Thermal control design includes:

- Maintaining the Imager as adiabatically (thermally isolated) as possible from the spacecraft structure.
- Controlling the temperature during the hot part of the synchronous orbit diurnal cycle (when direct solar heating enters the scanner aperture) with a north-facing radiator whose net energy rejection capability is controlled by a louver system.

Imager Optical Elements



- Providing makeup heaters within the instrument to replace the IR energy loss to space through the scan aperture during the cold portion of the diurnal cycle.
- Providing a sun shield around the scan aperture (outside the instrument FOV) to block incident solar radiation into the instrument, thus limiting the time the aperture can receive direct solar energy.

Detectors

The Imager instrument simultaneously acquires radiometric data in five distinct wavelengths or channels. Each of the five radiometric channels is characterized by a wavelength band denoting primary spectral sensitivity. The five channels are broadly split into two classes: visible (channel 1) and infrared (channels 2-5). For these five channels, the Imager contains a total of 22 detectors.

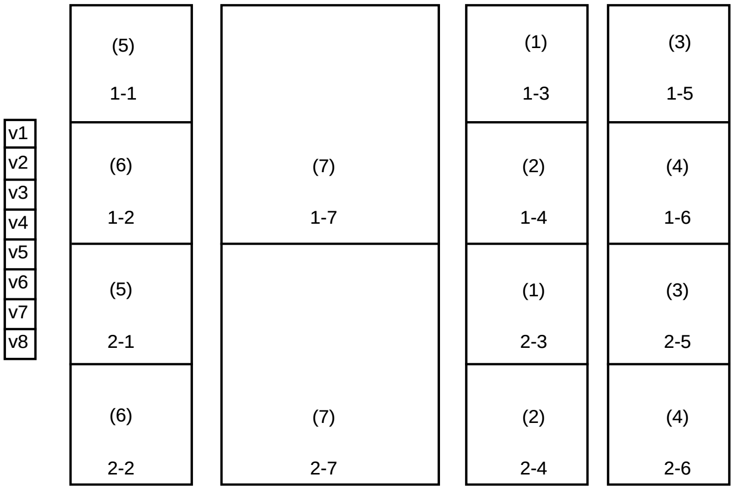
Visible Channel

The visible silicon detector array (channel 1) contains eight detectors (v1-v8). Each detector produces an instantaneous geometric field of view (IGFOV) that is nominally 28 microradians (µrad) on a side. At the spacecraft's suborbital point, on the surface of the earth, 28 µrad corresponds to a square pixel that is 1 kilometer (0.6 statute mile) on a side.

Infrared Channels

The IR channels employ four-element InSb (indium antimonide) detectors for channel 2 (3.9 µm), two-element HgCdTe (mercury cadmium telluride) detectors

Imager Detectors



Note: GVAR pixel numbers are shown in parentheses and are the same for sides 1 and 2.

CHANNEL	1	2	3	4	5
CENTRAL WAVELENGTH (µm)	0.65	3.9	6.75	10.7	12.0
DETECTOR IGFOV (nominal, µrad)	28	112 InSb	224 HgCdTe	112 HgCdTe	112 HgCdTe

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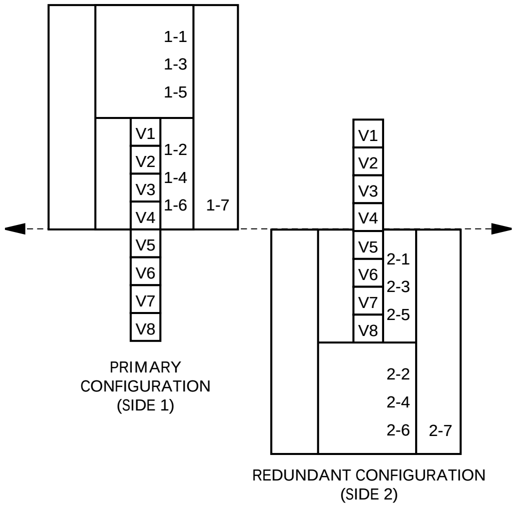
for channel 3 (6.75 µm), and four-element HgCdTe detectors for channels 4 (10.7 µm) and 5 (12 µm). A four-element set consists of two-line pairs providing redundancy along a line. Each detector in channels 2, 4, and 5 is square, with an IGFOV of 112 µrad, corresponding to a square pixel 4 kilometers per side at the suborbital point. Channel 3 contains two square detectors, each of which provides an IGFOV of 224 µrad, resulting in a suborbital pixel 8 kilometers on a side.

Configuration

The five detector arrays are configured in either a side 1 or a side 2 mode, either of which can be the redundant set by choosing side 1 or side 2 electronics. The entire visible channel array (v1 to v8) is always enabled in both modes. In side 1 mode the IR channels have only their upper detectors (1-1 to 1-7) enabled and in side 2, only their lower detectors (2-1 to 2-7). The GVAR numbering of the pixels is shown in the diagram.

Though physically separated in the instrument, the detector arrays are optically registered. Small deviations in this optical registration are due to physical misalignments in constructing and assembling the instrument and to the size of the detector elements. These deviations consist of fixed offsets that are corrected at two levels: within the instrument sampling electronics and on the ground by the operations ground equipment (no corrections are applied during star sensing).

Operational Configurations



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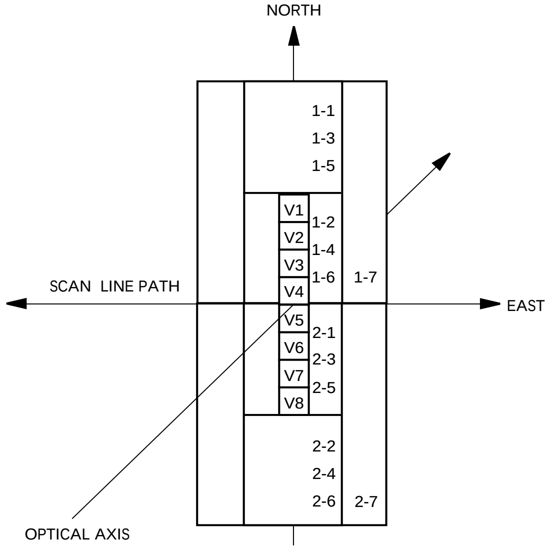
Optical Configuration



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Because the combination of scan rate (20°/s) and detector sample rate (5460 samples/s for IR and 21840 samples/s for visible) exceeds the pixel E/W IGFOV, the Imager oversamples the viewed scene. Each visible sample is 16 µrad E/W and each IR sample is 64 µrad E/W.

Scan Control

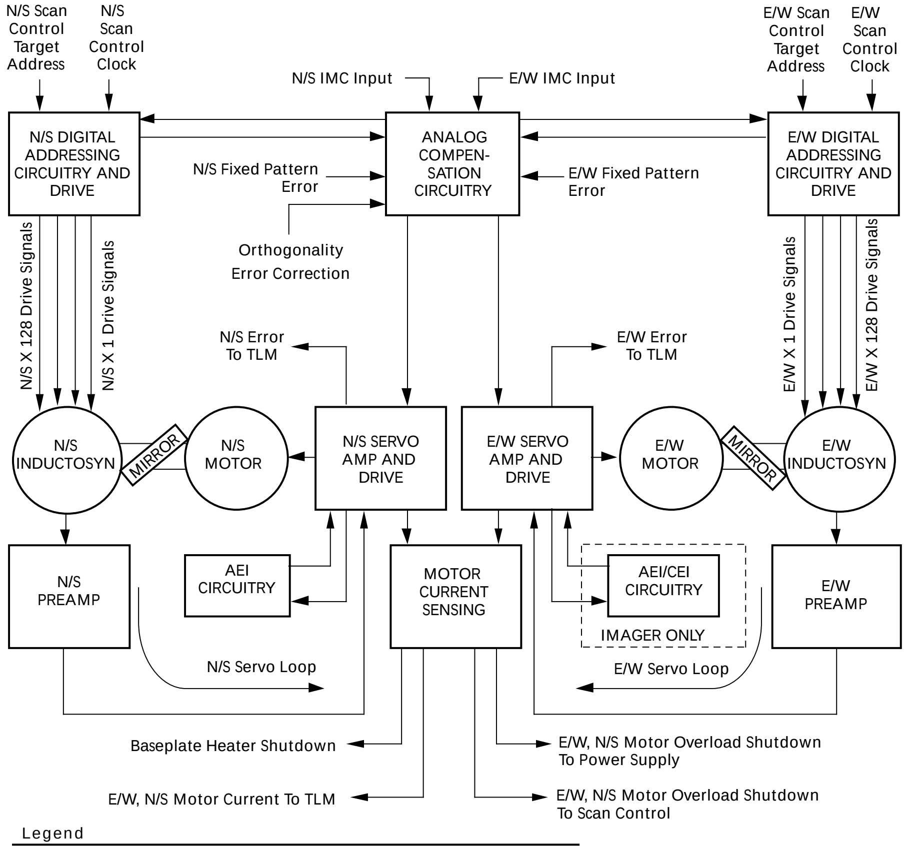
The scanning mirror position is controlled by two servo motors, one for the N/S gimbal angle, and one for the E/W scanning gimbal angle. Each servo motor has an associated inductosyn that measures the mechanical shaft rotation angle. The scanning mirror position and, hence, the coordinate system used for the Imager are measured in terms of the inductosyn outputs. Scan control for both axes is generated by establishing a desired angular position for the mirror. The desired angle is input to an angular position sensor (one inductosyn for each axis), which produces a displacement error signal. This signal is fed to a direct drive torque motor (one inductosyn for each axis) that moves the mirror and sensor to the null location.

For E/W deflection, the direct-drive torque motor is mounted to one side of the scan mirror and the position-sensing device (inductosyn position encoder) is mounted on the opposite side. All rotating parts are on a single shaft with a common set of bearings. Using components of intrinsically high resolution and reliability, coupling of the drive, motion, and sensing is therefore very tight and precise. North/South motion is provided by rotating the gimbal (holding the above components) about the optical axis of the telescope. This rotating shaft has the rotary parts of another torque motor and inductosyn mounted to it, again providing the tight control necessary.

Servo control is not absolutely accurate due to noise, drag, bearing imperfections, misalignment, and imperfections in the inductosyns. The principal servo pointing and registration errors are fixed pattern errors caused by the inductosyn position sensor and its electronic drive unit. Variations in individual inductosyn pole patterns, imbalance between the sine and cosine drives, cross-talk and feed-through in these circuits, and digital-to-analog (D/A) conversion errors contribute to the fixed-pattern errors. These errors are measured at ambient conditions and the correction values stored in programmable read-only memory. Corrections are applied in the scanner as a function of scan address. The measured values of fixed pattern errors vary between ±15 µrad (mechanical) with a frequency of up to four times the inductosyn cycle; after correction, the error is reduced to within ±4 µrad. Variations of the fixed pattern error over temperature, life, and radiation conditions are minimized by design, and residual errors are accounted for in the pointing budget.

Drive and error sensing components used for the two drive axes are essentially identical. The E/W drive system has a coherent error integrator (CEI) circuit that automatically corrects for slight changes in friction or other effects. Control components are optimized for their frequency and control characteristics, and logic

Scan Control Schematic



Legend

AEI	Average Error Integrator	IMC	Image Motion Compensation
CEI	Coherent Error Integrator	N/S	North/South
E/W	East/West	TLM	Telemetry

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is developed for the precise control of position in response to a system-level control processor.

Scan Operation

Scan control is initiated by an input command that sets start and end locations of an image frame. A location is defined by an inductosyn cycle and increment number within the cycle, the increment number determining the value of sine and cosine for that location. Each E/W increment corresponds to 8 µrad of E/W mechanical rotation and 16 µrad of E/W optical rotation. Each N/S increment corresponds to 8 µrad of N/S mechanical and optical rotation. The distance between a present and start location is recognized, causing incremental steps (8 µrad) to be taken at a high rate (10°/s) to reach that location. After the E/W slew is completed, the N/S slew begins. From the scan start position, the same pulse rate and increments are used to generate the linear scan. The scan mirror inertia smoothes the small incremental steps to much less than the error budget.

At the scan line end location (where the commanded position is recognized) the control system enters a preset deceleration/acceleration. During this 0.2-second interval, the scan mirror velocity is changed in 32 steps by using a 32-increment cosine function of velocity control. This slows and reverses the mirror so that it is precisely located and moving at the exact rate to begin a linear scan in the opposite direction. During this interval, the N/S scan control moves the gimbal assembly 224 µrad (28 increments of 8 µrad) in the south direction. Linear scanning and N/S stepping continue until the southern limit is reached.

Scan to space for space clamp, or to star sensing, or to the IR blackbody uses the same position control and slew functions as for scan and retrace. Command inputs (for star sensing or priority frames) or internal subprograms (for space clamp and IR calibration) take place depending on the type of command, time factors, and location.

Image Generation

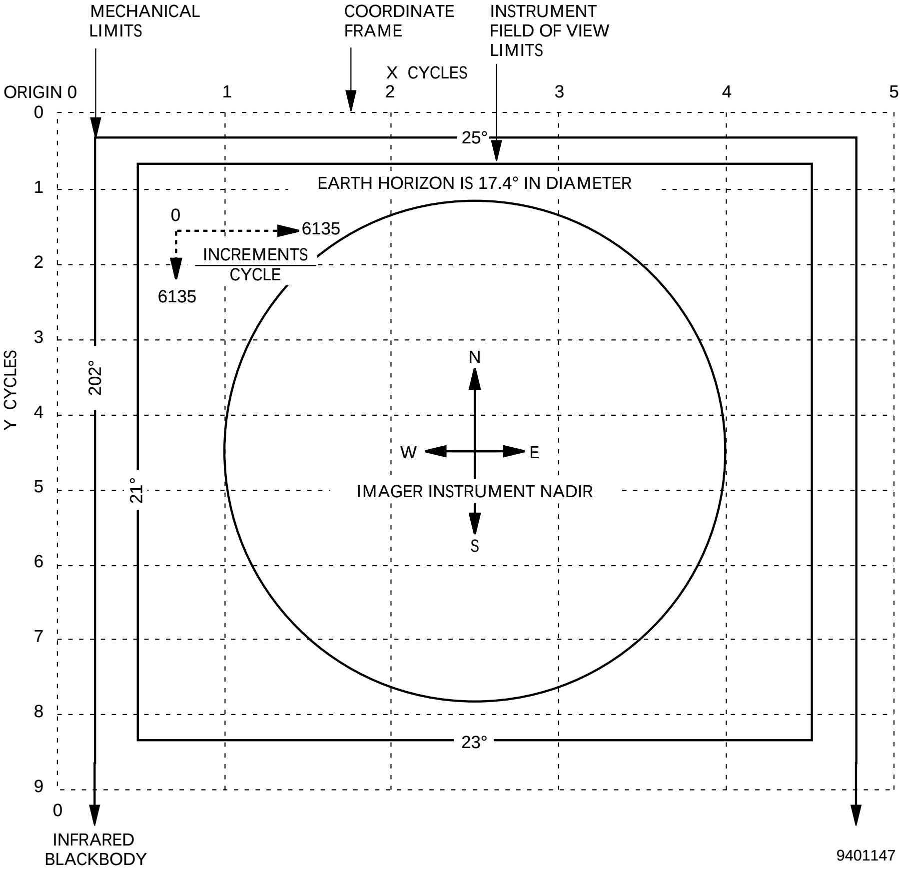
During imaging operations, a scan line is generated by rotating the scan mirror in the east-to-west direction (20°/s optically) while concurrently sampling each active imaging detector (5460/s for IR and 21840/s for visible). At the end of the line, the scan mirror elevation is changed by a stepped rotation in the north-to-south direction. The next scan line is then acquired by rotating the scan mirror in the (opposite) west-to-east direction, again with concurrent detector sampling. Detector sampling occurs within the context of a repeating data block format. In general, all visible channel detectors are sampled four times for each data block while each active IR detector is sampled once per data block.

The mapping between cycles and increments and the instrument FOV are referenced to a coordinate frame whose origin is zero cycles and zero increments (northwest corner of the frame). In geostationary orbit, the earth will be centered within the frame, at instrument nadir, which corresponds closely to the spacecraft suborbital point, also centered in the frame. The GVAR coordinate system is in line/pixel space and has its origin in the NW corner.

Three components making up the total misalignment in the sampled data are corrected by the instrument electronics and operations ground equipment:

- A fixed E/W offset caused by channel-to-channel variations in the signal processing filter delays.
- A fixed E/W and/or N/S offset caused by optical axis misalignments in the instrument assembly.
- A variable E/W and/or N/S offset caused by image rotation.

Imager Coordinate Frame



Electronics

The Imager electronics consist of a preamplifier and thermal control in the sensor assembly; command and control, telemetry, and sensor data processing contained in the electronics module; and the power supplies. The scan control electronics are contained in the electronics module. The servo preamplifiers are located at the scanner in the sensor module.

Signal Processing

Preamplification of the low-level visible and IR channel signals occurs within the sensor module. These analog signals are routed to the electronics module, which amplifies, filters, and converts the signals to digital code. All channels in the visible and IR bands are digitized to one part in 1024 (10 bits), the visible for high-quality visible imagery and to aid star sensing capability, and the IR for radiometric measurement. Data from all channels move in continuous streams throughout the system, thus each channel's output must enter a short-term memory for proper placement in the data stream. Each channel is composed of a detector, preamplifier, analog-to-digital (A/D) converter, and signal buffer. All signal chains are totally independent and isolated. Redundant chains of signal processing circuitry are provided with each circuit ending in a line driver designed to interface with the spacecraft transmitter (the video and formatter are redundant for the IR channels only).

Electronic Calibration

Electronic calibration signals are injected into the preamplifiers of channels 3, 4, and 5 while the Imager is looking at space. Electronic calibration is inserted after the preamplifiers of channels 1 and 2. Sixteen precise signal levels derived from a stepped D/A converter are inserted during the 0.2-second spacelook. The calibration signal, derived from a 10-bit converter of 0.5-bit accuracy, provides the accuracy and linearity for precise calibration.

Visible Channel

Each detector element of the visible channel has a separate amplifier/processor. These current-sensing preamplifiers convert the photon-generated current in the high-impedance silicon detector into an output voltage, with a gain of about 10^8 V/A. These preamplifiers are followed by postamplifiers that contain electrical filtering and space clamping circuits. The digitization of the data signals is also part of the space clamp circuitry. The visible information is converted to 10-bit digital form, providing a range from near 0.1% to over 100% albedo. Differences of approximately 0.1% are discernible, and the linear digitization provides for system linearity errors of 0.5 bit in the conversion process. The star sense channel uses the same visible channel detectors, but boosts the gain by approximately 4 times and reduces the bandwidth.

Infrared Channels

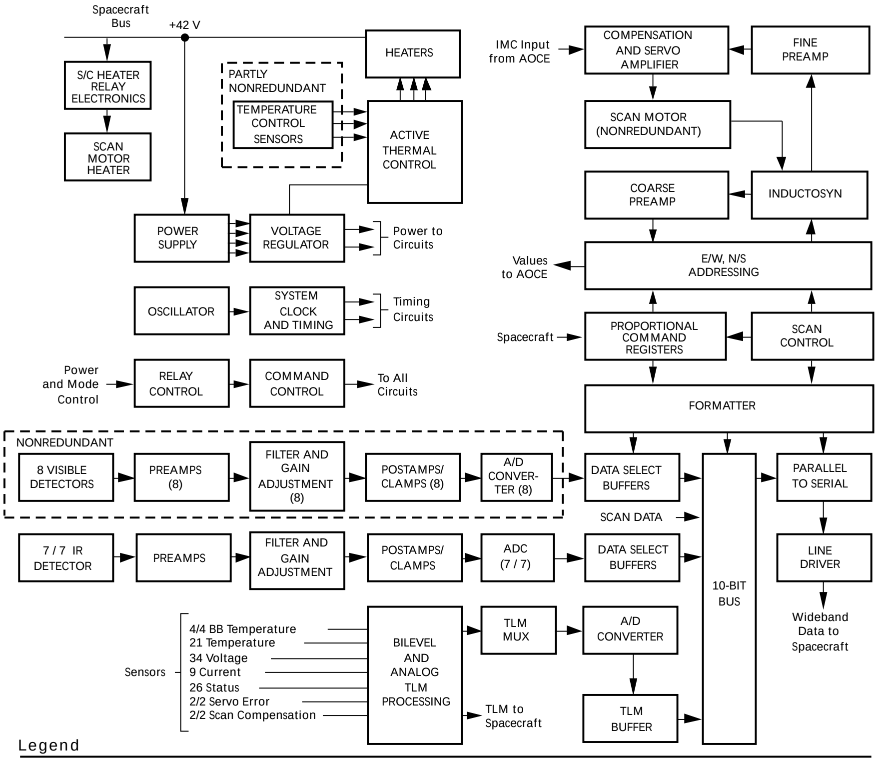
The IR channels have a separate amplifier/processor for each detector element. The 3.9 μm channel has a hybrid current sensing preamplifier for the high-impedance InSb detector. Individual preamplifiers for channels 3, 4, and 5 are mounted on the cooled patch in the sensor module.

The IR information is converted to 10-bit digital form, providing a range from near 0.1% to over 100% of the response range. Each channel has a gain established for a space-to-scene temperature of 320 K. The 10-bit digital form allows the lowest calculated noise level to be differentiated. The digital system is inherently linear with A/D converter linearity and accuracy to 0.5 bit. The binary-coded video is strobed onto the common data bus for data formatting by the system timing and control circuitry.

Formatting

The data format of Imager information is made up of blocks of data generated in a given sample time period. The Imager scans an 8-kilometer swath using combinations of 1-kilometer visible detectors, and 4- and 8-kilometer IR detectors. Oversampling causes the IR data to be collected each 64 μrad (2.28 kilometers or

Imager Block Diagram



Legend

A/D	Analog to Digital	MUX	Multiplexer
ADC	Analog-to-Digital Converter	S/C	Spacecraft
AOCE	Attitude and Orbit Control	TLM	Telemetry
IR	Electronics		

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1.42 statute miles at nadir) using a data block format where the location of each bit within the data stream is completely identified, and all information can be separated and reformatted on the ground. The visible detectors are sampled four times during this 64 µrad period, yielding a collection rate of 16 µrad per sample. The four sets of visible data combine with one set from each IR detector in each data block.

The formats consist of data blocks, 480 bits in a block, each block being broken into 48 10-bit words. The format sequence during an active scan begins with a start-of-line command from the scan control system that synchronizes the data formatter with scan control and occurs when the Imager mirror is at the start of a scan line. The header format follows, containing block synchronization and data block identifiers, spacecraft and instrument identification, status flags, attitude and orbit control electronics data, coordinates of the current scan mirror position, and fill to complete the data block. After the header block, active scan data blocks follow; these contain synchronization and data block identifiers, motion compensation data, servo error, and radiometric data.

When the mirror reaches the end of the scan line, a scan reversal sequence begins with three active scan data blocks that permit full collection of radiometric data to the end of the scan line. A trailer format, similar to the header format, identifies the 39 blocks of telemetry format data to follow.

Digital signal processing starts where data from the IR and visible detectors and telemetry merge via multiplexing and processing; a parallel-to-serial conversion and data multiplexing take place to bring sensor data together. Other information, such as synchronization pulses, scan location, and telemetry data, is assembled in the data select circuitry. These data are then passed through a line driver where pulse amplitude and impedance levels are set for the transmitter interface. These data are transmitted at a rate of 2.6208 Mb/s or 5460 blocks per second.

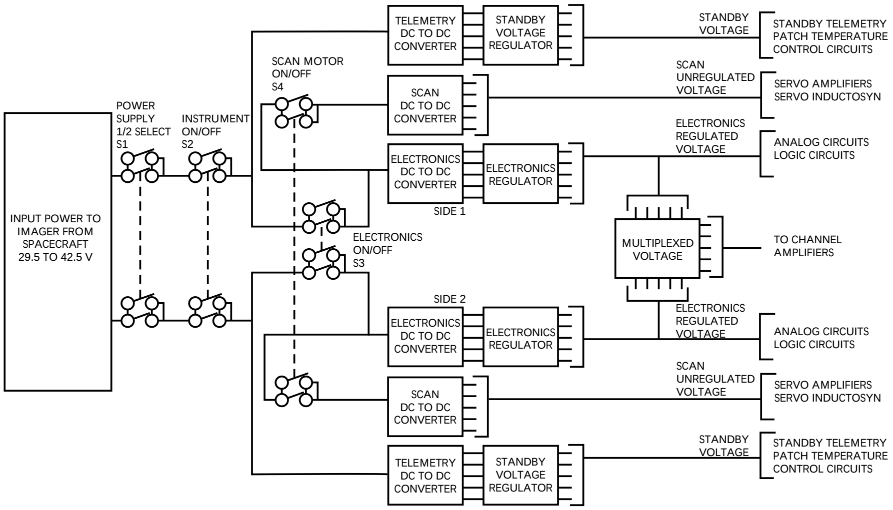
Power Supply

The power supply converts spacecraft main bus voltage (29.5 to 42.5 volts) to the required instrument voltages. There are two sides (1 and 2) to the unit, each totally independent and selected by command, although only one side operates at a time. A protective resistive filter permits operation of all nonredundant circuits (command input circuitry, inductosyn preamplifier, patch temperature control, detector preamplifiers, etc.) by either side. Redundant circuits are powered through separate fused links from the respective side that prevents system loss in the event of failure.

The power converters of both sides accept and convert the bus voltage to a steady 26.5 volts dc using switching regulators. The regulator output voltages power both the main and a standby dc/dc converter for the electronics during normal operation. The main converter consists of a power amplifier, transformer, rectifiers, and filters. It provides unregulated voltage to operate the servo power amplifiers and servo inductosyn drivers, and regulated voltage used principally to operate analog circuitry in the Imager and also power the logic circuitry.

The standby dc/dc converter consists of a synchronized oscillator, rectifiers, filters, and regulators and is used to operate the standby telemetry and patch temperature control circuits. It also provides a boost voltage used to improve the efficiency of the switching regulator and a 40-kHz signal that synchronizes the input to the main converter.

Power Supply Block Diagram



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