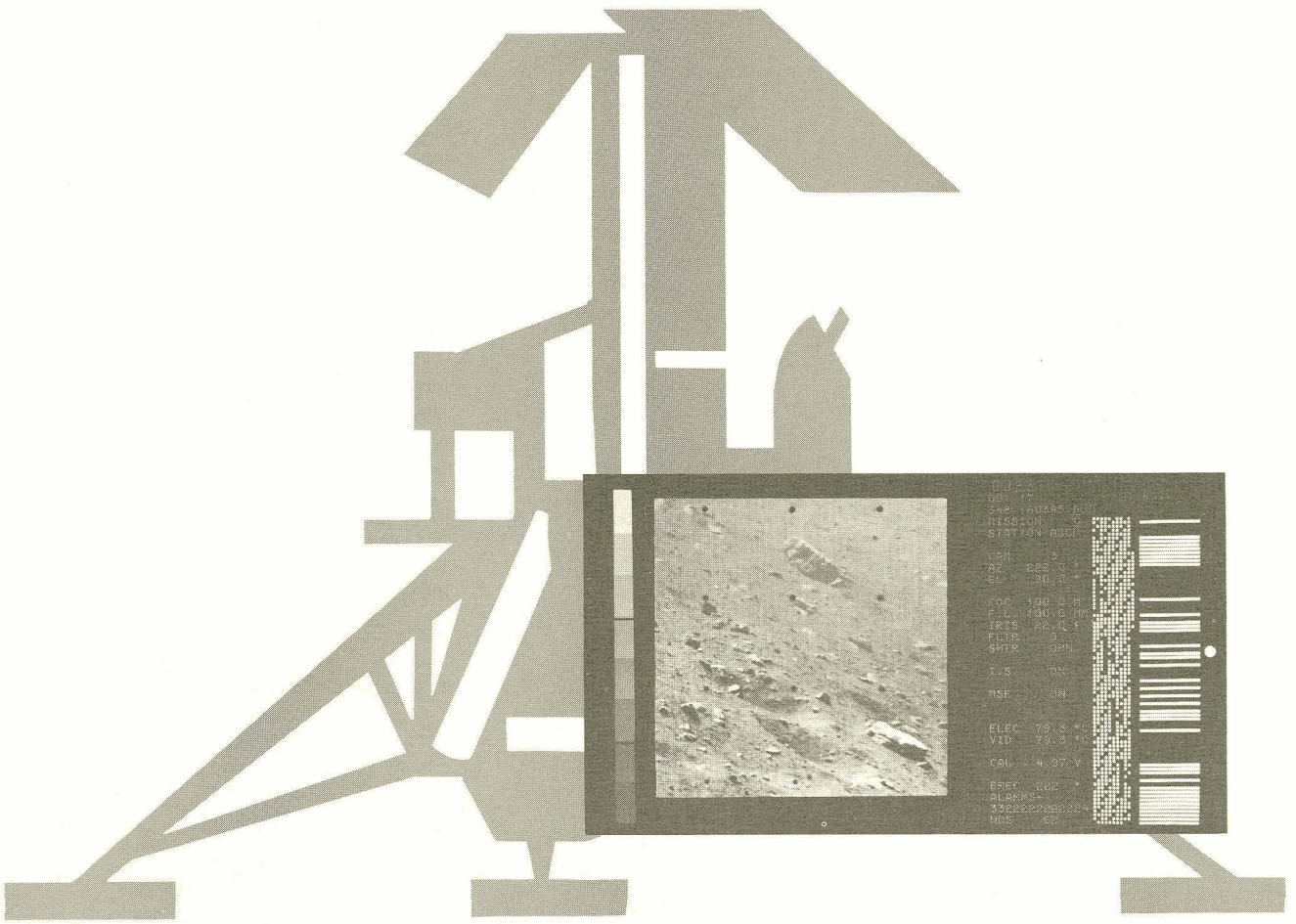


SPACECRAFT TELEVISION GROUND DATA HANDLING SYSTEM

PAVING THE WAY FOR FUTURE SPACE EXPLORATION

Man has long wondered what is on the moon. Today he knows what the surface of the moon looks like and what its texture is through the reproduction of television pictures transmitted from the lunar surface. This extraordinary achievement was made possible through the development of the Spacecraft Television Ground Data Handling Systems (SCTV/GDHS) — a multi-million dollar operational system that recovers, records and reproduces television and telemetry signals transmitted back to earth.

The primary function of this system is to provide scientists with permanent photographic evidence of what the spacecraft television camera sees on the moon and other planets. Today, it is being used to support our unmanned lunar voyages . . . a program designed to provide visual information that will assist in certifying potential Apollo soft-landing sites.

Built in cooperation with Jet Propulsion Laboratories (JPL) in Pasadena, California by the Link Group of General Precision Systems Inc., the SCTV/GDHS has played a vital role in the successful Surveyor Missions—America's lunar soft-landing space flights. In fact, this system has reproduced every photograph that has been transmitted from the surface of the moon.

PHOTOMOSAICS . . . COMPLETE PHOTO SURVEILLANCE

After recovery and reproduction of the individual pictures of the moon by the SCTV/GDHS, they are compiled into a photomosaic. These photomosaics provide scientists with the means to study a complete picture of the lunar surface that is within range of the spacecraft television camera.

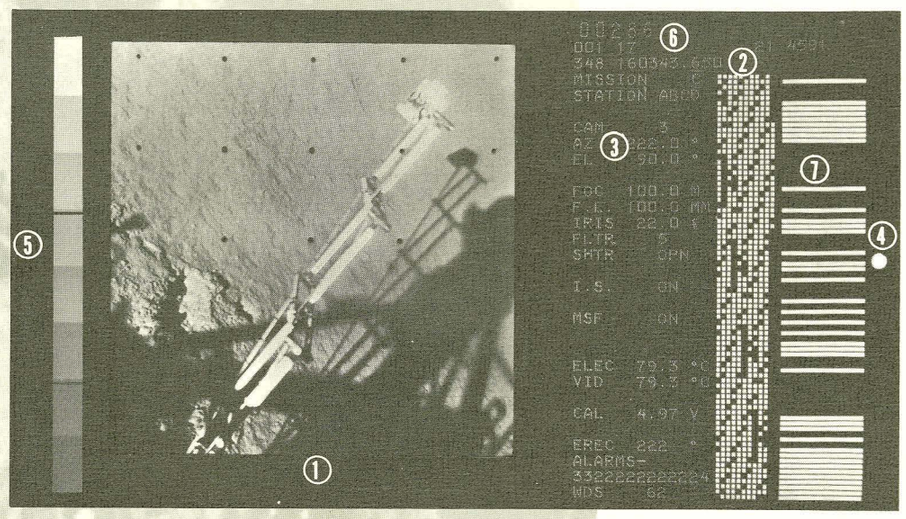
A UNIQUE SYSTEM DEVELOPED TO SUPPORT DEEP SPACE EXPLORATION

The Spacecraft Television Ground Data Handling System (SCTV/GDHS) is one of the most unique systems ever developed to support deep space exploration. This system, designed and produced by the Advanced Products Division of the Link Group, General Precision Systems Inc., photographs television images and telemetry data transmitted by a spacecraft on 70mm film. Every Surveyor picture, from every successful mission, was recorded by this Link system.

Television signals received by the system are converted to pictures and written on unexposed 70mm film through the use of a high precision CRT flying spot scanner. Telemetry data, received after the picture, is in a signal format. As this data arrives, it is converted by a computer into a human readable format (letters and numbers). All information—data in its signal format, data in its human readable format and the picture are recorded on film at exactly the same instant.

The SCTV/GDHS has the added capability of converting television pictures received in a 200 or 600 line format to a 525 line format in real-time. This allows the received picture to be broadcast over closed circuit and commercial television — allowing the general public to view these pictures at the same time as scientists.

The process of converting telemetry data and exposing the picture and data on film is actually completed on earth in less than 4 seconds after it has been transmitted by the spacecraft.



70mm FILM CHIP . . . A COMPLETE AND PERMANENT PHOTOGRAPHIC RECORD

The Spacecraft Television Ground Data Handling System has provided scientists with thousands of complete and permanent photographic records of what the spacecraft television camera has seen on the moon.

Each 70mm film chip contains a multitude of information that has been written on the unexposed film by a CRT flying spot scanner. The greatest portion of this information is generated by the FM video (picture) and telemetry (data) signals received from the spacecraft. A small portion is generated at the Space Flight Operation Facility (SFOF) in Pasadena, California.

Information Generated From The Video And Telemetry Signals

1. An image area 48mm square containing the video picture.
2. The raw-ID (identification) bit stream, 80 bits high by 11 bits wide, represents the telemetry data in machine readable format. The bits are decoded by the computer into a human readable format.
3. The identification block containing the mission number, station, camera number and 12 different camera parameters in a human readable format.

Information Generated At SFOF

4. Camera number that produced the film chip.
5. Electrically generated gray scale.
6. Machine readable bar code in a human readable format. Shows the record number, format number, process code number, DSIF code number, mission code number and time.
7. Machine readable bar code which can be utilized for automatic storage and retrieval.

THE SPACECRAFT TELEVISION GROUND DATA HANDLING SYSTEM . . . AN INTEGRATED ELECTRONIC AND PHOTOGRAPHIC COMPLEX

Television images, in the form of FM signals, are first received from the spacecraft by the Deep Space Instrumentation Facility (DSIF) at Goldstone, California . . . one of the initial ground receiving stations.

These signals are fed into a Link Data Recovery Unit at DSIF. The basic function of the system is to lock onto the video picture and telemetry data portions of the signal. The output of the Recovery Unit (picture and data) is fed into the Link Film Recorder, which uses a precision flying spot scanner to expose the picture and telemetry data on 70mm film. At the same instant, these signals are transmitted via microwave to the Space Flight Operations Facility (SFOF) at JPL in Pasadena.

At SFOF these signals are fed into another Link Data Recovery Unit (1) where they are immediately demodulated and stripped of Pulse Code Modulated (PCM) data or telemetry data. The data portion is fed into the On-Line Digital Computer (2) with the picture portion going directly to the two Film Recorder Units (3 & 4).

The computer "reads" the telemetry data as it arrives at SFOF and converts it into "human readable" data. This human readable ID (identification) and the telemetry data or raw identification bit stream is fed into the Film Recorder and exposed on film at the same instant as the picture. At the same time it is displayed in the control room at SFOF so that scientists can evaluate the data.

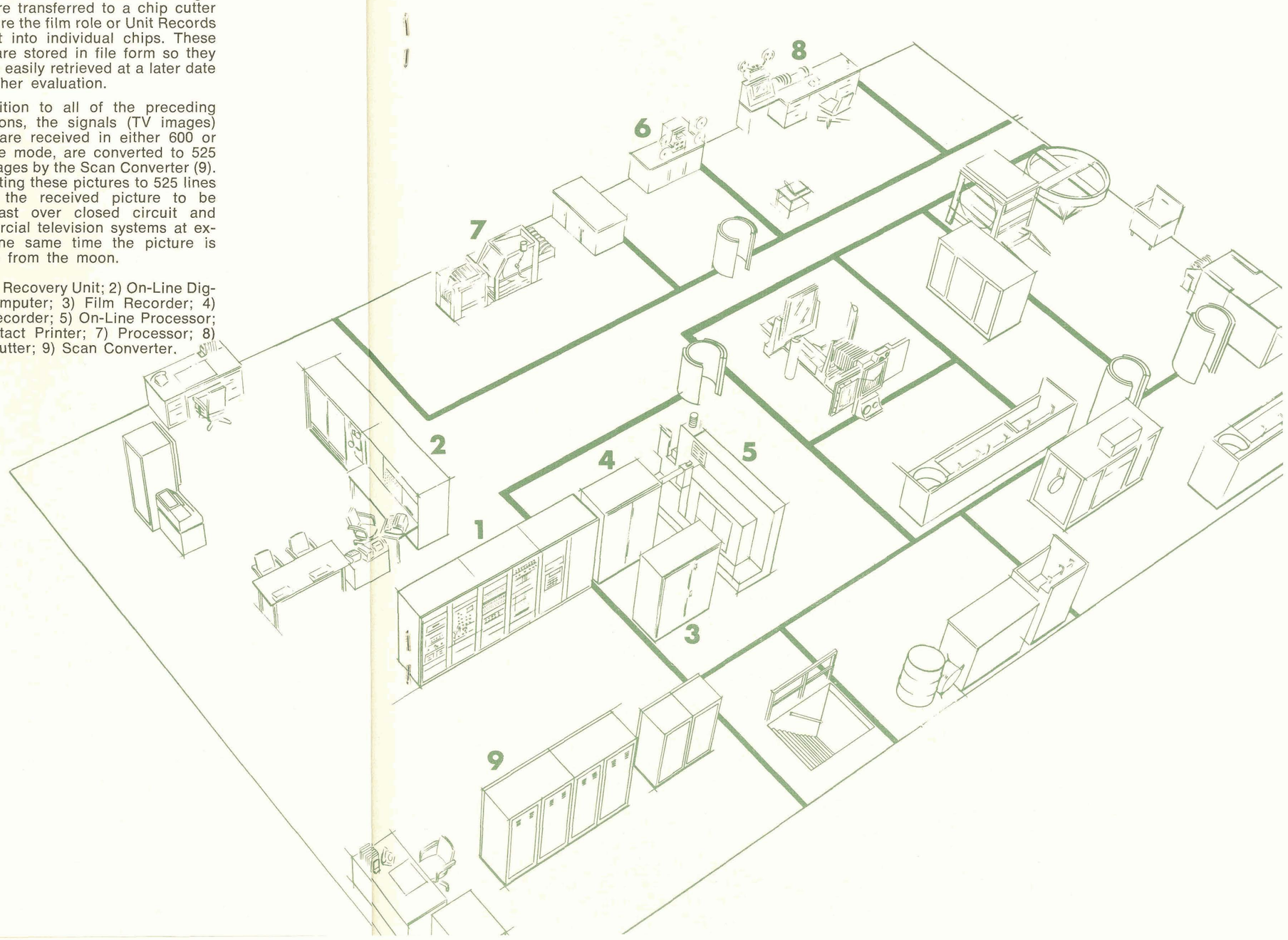
One Film Recorder (3) generates exposed film that is removed and processed separately at a later time. The other Film Recorder (4) which is mechanically-coupled to an On-Line Processor (5), continuously feeds exposed film into the processor housing. The unit simultaneously processes 70mm positive and negative transparencies at the rate of about 30 pictures per minute.

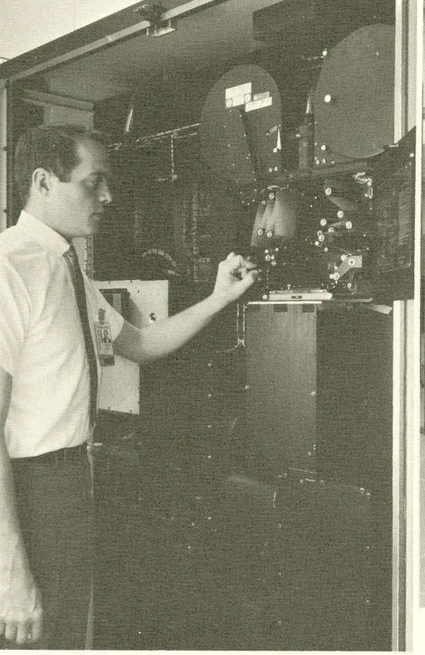
Converting data, and exposing the picture and data on film, is completed in less than 4 seconds after transmission by the spacecraft.

Exposed and processed negatives are used to produce contact prints (6) which are processed (7) and released to scientists and analysts at JPL for immediate evaluation. After these contact prints have been made the negatives are transferred to a chip cutter (8) where the film role or Unit Records are cut into individual chips. These chips are stored in file form so they may be easily retrieved at a later date for further evaluation.

In addition to all of the preceding operations, the signals (TV images) which are received in either 600 or 200 line mode, are converted to 525 line images by the Scan Converter (9). Converting these pictures to 525 lines allows the received picture to be broadcast over closed circuit and commercial television systems at exactly the same time the picture is coming from the moon.

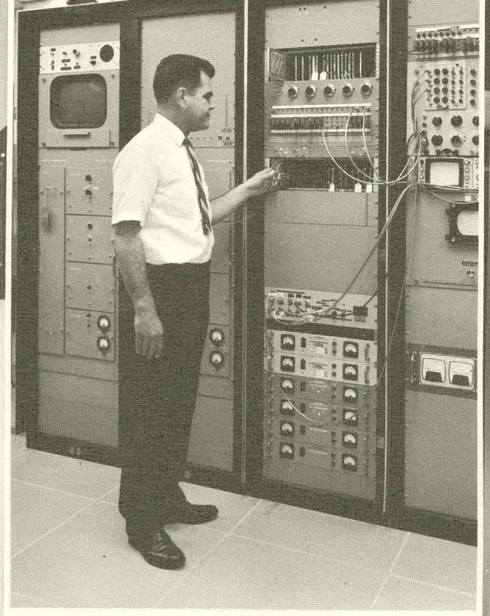
1) Data Recovery Unit; 2) On-Line Digital Computer; 3) Film Recorder; 4) Film Recorder; 5) On-Line Processor; 6) Contact Printer; 7) Processor; 8) Chip Cutter; 9) Scan Converter.





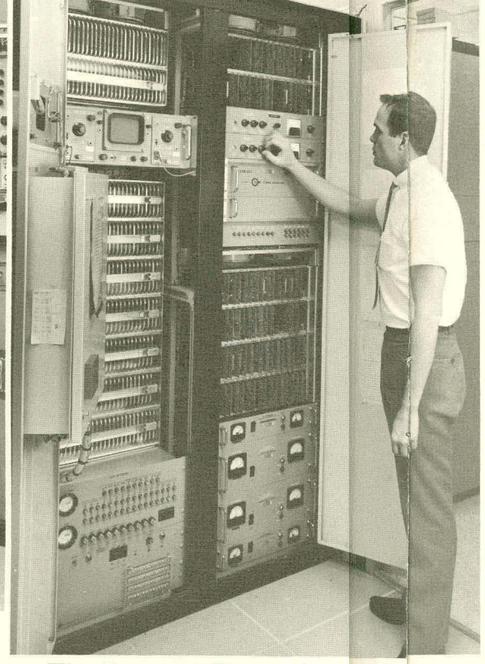
Film Recorder

During the actual mission, pictures are printed on the cathode ray tube and transferred optically to the 70mm film in real time.



Scan Converter

Converts 600 and 200 line pictures to 525 lines for presentation on commercial and closed-circuit television.



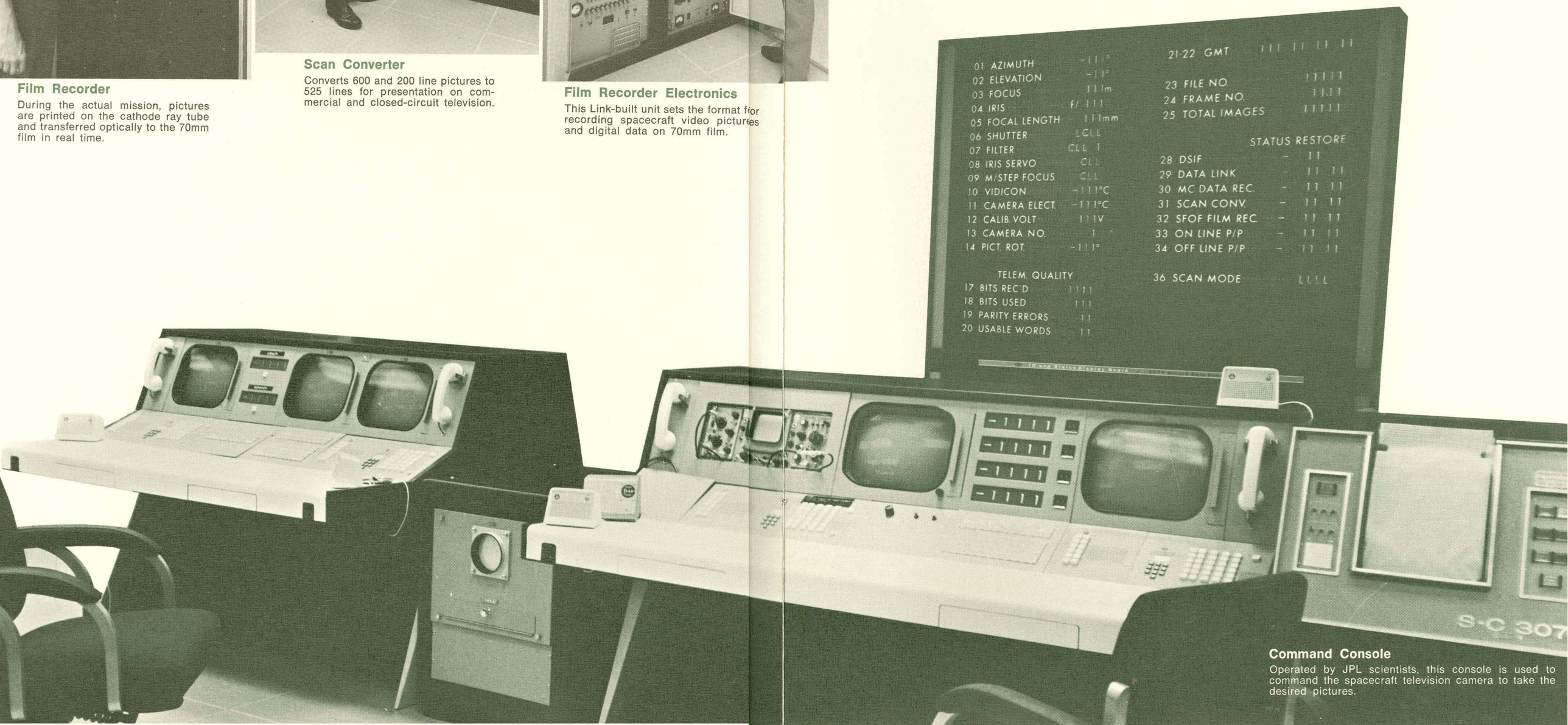
Film Recorder Electronics

This Link-built unit sets the format for recording spacecraft video pictures and digital data on 70mm film.

DEVELOPED, PRODUCED AND OPERATED BY LINK ENGINEERING PERSONNEL

From the initial development of the Spacecraft Television Ground Data Handling System, to the final production of photos of the moon's surface, Link engineering personnel have provided the complete service . . . design, production, operation and maintenance.

A complete staff of Link engineering personnel were originally assigned at JPL at the time of the system's installation. Stationed there under contract, they operate the entire system under the direction of JPL cognizant personnel. Included in this operation is the responsibility of providing complete and continual maintenance and updating of the system.



Command Console

Operated by JPL scientists, this console is used to command the spacecraft television camera to take the desired pictures.

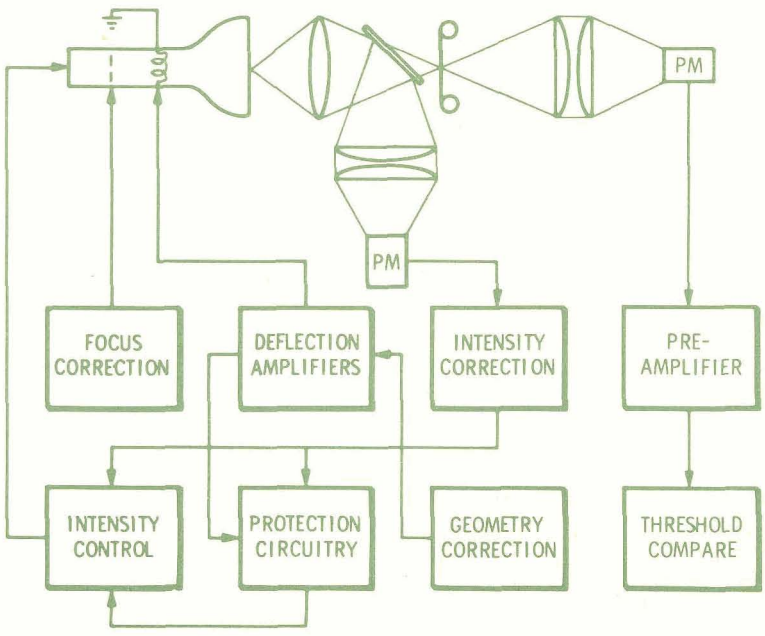
HIGH PRECISION FLYING SPOT SCANNER

MAIN FRAME OF LINK SYSTEMS

By selecting various modules and subsystems from our High Precision Flying Spot Scanner main frame, Link has designed and produced a variety of systems which operate in both a read and write mode. These systems are presently being utilized in numerous applications. A portion of these include the high speed recording of video, graphic and alphanumeric data on film (write mode) and conversion of filmed images into digital data for computer input, processing and display (read mode).

Both modes use a beam of light from the CRT which is focused into a very small (high resolution) spot. In the write mode, digital values specified by the computer are converted into light signals which write on the unexposed film. In the read mode, a constant intensity light signal passes through the exposed film, varying the output intensity which is then converted to a digital value.

Modular in constructions, the Link Graphic Data Conversion Systems make use of a flying spot scanner main frame with high precision deflection, focus and intensity currents. Principal concern is given to each system's basic parameters with emphasis placed on the accuracy of the electron beam spot size and intensity, static and dynamic focus, geometric correction, scaling and deflection.



SUBSYSTEM SPECIFICATIONS (ON-SITE and SFOF)

Data Acquisition & Recording:	Pre-detection recording on video and telemetry magnetic tape recorders.
(Performed by DSIF)	frequency converters microwave relay
Data Recovery:	operates in real time or tape playback synchronizers provide rapid (less than 0.2 sec access) horizontal sync, vertical sync, and telemetry bit sync. operated to —10db carrier/noise ratio removes video tape head switching transients
Cathode Ray Tube Monitor:	corrects for CRT variations

SUBSYSTEM SPECIFICATIONS (SFOF EQUIPMENT)

On-Line Digital Computer:

a. PCM decommutation
b. reduce raw telemetry to engineering units
c. automatic image erection for scan converter
d. drive I.D. and status display
e. off-line storage and retrieval of film chips
f. digital format film recording

Data Recovery

Operates in real time or tape playback
Synchronizers provide rapid (less than 0.2 sec.) horizontal SYNC, vertical SYNC, and telemetry bit SYNC.
Operated to −10db carrier/noise ratio.
Removes video tape head switching transients.

Media Conversion Film Recorder:

Electronic Distortion:	less than ± 0.1%
Optical Distortion:	does not exceed 0.05% of picture width
Optical Gray Scale Levels:	capability of 15 steps at increments of .15 density
Cathode Ray Tubes:	a. 7 inch precision CRT b. spot size 0.8 mil diameter c. protected against sweep failure or over-brightness
Density Range:	0.1 - 2.25
Raster Scan:	analog 600 or 200 line picture
Human Readable Legend:	64 character generator from digital computer inputs and internal fixed format includes time and frame number
Machine Readable Code:	capable of indexing film for automatic storage and retrieval code includes event time record
Raw Telemetry:	all PCM data recorded
Electrical Gray Scale Wedge:	8 gray level steps
Gamma Correction:	from 0.5 to 2.0 exposure computer can be normalized to any input level dynamic focus correction sweep velocity correction H & D curve compensation
Photo Multiplier Loop Monitor:	corrects for CRT variations

Photo Processing

On-Line Via Bimat Processor:	processing rate, 10 feet/min. max. throughout time, 5 minutes output, positive and negative transparencies
Off-Line:	roll film and roll paper processors
Storage and Retrieval:	chip and archival storage 20,000 chip file
Display and Analysis Support:	I.D. and status display engineering console science console
Scan Converter:	converts 600 and 200 line picture to 525 lines

The Spacecraft Television Ground Data Handling System incorporates various hardware, techniques and capabilities acquired by the Link Group during several years of successful experience and reliable performance in precision flying spot scanning and film recording techniques. It is just one of many highly sophisticated systems, designed and built through the use of available modular subsystems that reflect the very latest advancements in the state-of-the-art. This modular subsystem approach enables Link to supply custom-engineered systems as virtually standard items . . . providing customers with the maximum in operational functions at a minimum cost.

The Link Group of General Precision Systems Inc. is a world-wide organization with unique problem solving capabilities, proficient in the area of total systems support or any of its elements.

For additional information on the application of Link's data conversion capabilities to your program requirements, please contact:

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