For Network Personnel Only

TECHNICAL INFORMATION BULLETIN

THE MANNED SPACE FLIGHT NETWORK

Volume 6 No. 3 Goddard Space Flight Center February 20, 1969

AS-504 Mission Will Test Newest Space TV Camera

When several years ago a prominent man termed television as a "vast wasteland," he perhaps did not realize how prophetic he was.

Last December, television viewers received their first views of the lunar landscape from about 70 miles. Before this year is over it is expected that closeups of the face of the moon will be taken by astronauts and transmitted to the homes of TV viewers around the world. From the previews shown during AS-503, we will be truly getting a first hand view of a "vast wasteland."

The camera that will be used to send these TV pictures across the 250,000 miles of space will be tested during the AS-504 mission. Designated as the Block II Lunar Module Camera, it will receive a thorough checkout during the 10-day flight and be ready for a lunar landing mission later this year.

Integrated circuits make up 80 percent of the LM camera's electronics. A rugged unit, small enough to be held in one hand, the camera uses an improved version of a recently developed tube to operate in the brightness of the lunar day and in near-darkness, when the only illumination is light reflected from the earth--a light range from 0.007 to 12,600 foot-lamberts. The lower limit of this range would be equivalent on earth to the light from a quarter-moon, the highest level to the light from an overhead sun on a clear summer day. Although lenses will be interchanged to optimize light sensitivity, the camera won't require any internal adjustments.

Only one camera will be taken on the lunar landing trip, a unit designed for a 99.9 percent probability of success over the 360-hour duration of the mission. It is built to operate in the severe vacuum environment of the moon at temperatures ranging from 250° to -300° F; passive cooling will hold camera temperature between 0° and 116° F. The camera is also designed to operate in the humid and corrosive atmosphere of the spacecraft

The only external control is a switch to change operation from slow to fast scan. For high-resolution scientific studies, the camera will be mounted on a tripod and will scan the scene at a rate of 5/8 frame per second with 1,280 lines per frame. Where high resolu-

Please Turn to Page 2

Closed Circuit TV

New closed circuit television systems are being installed at Goldstone, Madrid, and Honeysuckle Creek. Each system will include three cameras and the associated equipment.

At Goldstone and Honeysuckle one camera will be located so as to provide surveillance of the antenna during slewing operations. The antenna operator will then be able to view the antenna area normally obscured by the antenna pedestal.

The two remaining cameras are equipped with remote controlled zoom lenses and pan tilt heads and will be mounted in prime interest areas of the station. The cameras will furnish TV monitored presentations of the station operations to the visitors area.

At Madrid all three cameras will provide viewing of station operations at the visitor area, about 1,000 feet from the instrumentation building. The TV system makes it possible for visitors to view a station during mission time

ORBIT OR REVOLUTION

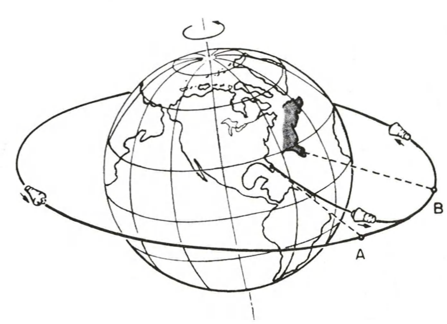
In spacecraft terminology, the terms orbit and revolution are often used interchangeably. Although they are closely related, they are not synonymous.

A satellite in space moving around a planet such as the earth, under the influence of gravity alone, travels in an elliptical path. This path is known as an orbit. When the satellite makes a complete trip through its path, the trip is called a revolution. The time required for a satellite to make one complete revolution is called its period, or period of revolution.

The speed of a satellite through its orbit remains constant, but the time required for a complete orbit depends upon the position of the observer. If the observer is stationed far out in space, the speed of the satellite is expressed in terms of the time it takes to make a complete orbital revolution in relation to a point referenced to fixed stars. This kind of time is sidereal time; the word sidereal meaning "of or relating to stars." If, however, the observer is positioned on the earth, he uses his own position as a reference point. Since the earth is rotating, the observer's position is also in motion, therefore if the direction of the satellite is the same as the earth's rotation, the period of revolution thus timed would be greater than a sidereal period. Conversely, if the satellite was moving in a direction opposed to the earth's rotation, period of revolution would be less than the sidereal time period. A period of revolution measured by an observer on the earth's surface is termed "synodic", meaning a "meeting or conjunction".

In day-to-day practice, synodic periods are referred to as revolutions; sidereal periods as orbits. During the 14-day Gemini VII mission for example, astronauts Borman and Lovell completed 206 revolutions and 220 orbits.

For MSFN use, an orbit is the path of the spacecraft around the earth (or moon) from a point in space to that same point in space; a revolution is a complete cycle around the earth (or moon), starting and ending with the same point of longitude or latitude.



In this drawing, one orbit is from point A, around the earth, and back to point A. Since the longitude of Cape Kennedy has rotated about 23 degrees to the East (point B), one revolution has not been considered completed until the spacecraft has traveled this additional "Distance" and is again over the longitude of Cape Kennedy.

Test TV Camera

Continued From Page 1

tion is not required and the subject may be moving--for example, to monitor the astronauts' movements--the camera can be hand-held and will scan the scene at 10 frames per second with 320 lines per frame. Unlike the conventional broadcast television format, the lines won't be interlaced.

After touchdown on the moon's surface and erection of an S-band antenna, the astronauts will connect a combination handle-electrical connector to the camera; the handle can be engaged or disengaged in a vacuum without the contacts welding together. The handle is hooked up to a 100-foot cable that will supply the camera with dc power from the LM and will also connect the camera's video output with the LM's S-band transmitter. After selecting a lens appropriate to the light conditions and the scene to be viewed, an astronaut will switch to the desired scan mode. He will use the edges of the camera as an aiming sight.

The heart of the LM camera is a sensitive image tube that combines a variable-gain light intensifier with a secondary electron conduction (SEC) target. This target produces gain and stores the image that is subsequently scanned by the tube's electron beam gun. Although the tube is slightly less sensitive than an image orthicon, the electronics for reading out the stored image are as simple as those of a vidicon tube. With fast response, the SEC tube's video output signal at low light level reproduces objects in motion without smearing--unlike the video output of vidicon and image orthicon tubes. At the same time, the SEC target can store and integrate signal information over a relatively long time period, a factor that contributes to the tube's slow-scan capability and sensitivity.

The camera is provided with four interchangeable lenses of fixed focal length. A wide-angle lens will be used primarily for pictures inside the command module, while a telephoto lens will be used to view the earth and moon during the trip back and forth. Two general-purpose lenses will be used on the moon's surface, one during the lunar day and the other during periods of darkness.

The lenses focus light onto the electrostatic diode image intensifier's photocathode, which emits electrons in proportion to the incident light level. A faster lens--one with a larger aperture--collects more light and thus increases the number of emitted electrons.

The potential difference between the photocathode and the SEC target accelerates the emitted electrons and the intensifier's electronic optics focus the image onto the SEC target.

Depending on the incident light level, an automatic control circuit varies the accelerating potential so that electrons hitting the target have energies ranging from 2,000 to 8,000 electron volts, with the higher energy level corresponding to low light levels. In this way, the tube is able to accommodate a wide range of illumination while maintaining a relatively constant signal output.

The SEC target releases secondary electrons in proportion to the number and energy of the impinging electrons. These secondary electrons are collected by a thin aluminum plate that is at a higher potential than the target material. As a result, each point on the face of the target becomes positively charged in proportion to the incident light level.

The operation of reading the stored image out of the SEC target is similar to that in a vidicon tube. When the electron gun scans across the target, it neutralizes the charge and brings the target potential back to ground level. This change in charge results in a current pulse that is coupled to an external resistor. The voltage developed across the resistor is the video signal.

The tube's image intensifier and 1-inch hybrid vidicon gun are especially rugged but are otherwise of conventional design. Because the gun is electrostatically focused, it requires only simple external circuitry. Although a magnetically focused gun would improve the tube's resolution, the focus coil would appreciably increase weight and power requirements.

Except for the unregulated dc supply from the spacecraft, the camera is a self-contained unit. The SEC tube and deflection surface provide the basic conversion from optical to electrical signals, while a combined automatic light-level control and gain control (ALC/AGC) maintains a constant video output even as light levels change. Video amplifiers boost the signal and mix it with sync signals and blanking pulses developed in the synchronizer.

The amount of surface area needed to maintain thermal balance at lunar noon determines the camera's size and weight. Besides having the appropriate cooling properties for lunar operation, the surface finish must withstand the corrosive atmosphere of the spacecraft. The finish used will hold the camera's surface-temperature below 120° F during lunar day if the top surface can reflect into deep space. For night operations on the moon, camera temperature may drop as low as -44° F. However, 27 square inches of silver shields can be attached to the unit's top surface to prevent radiation of heat outward and hold the low temperature to 0° F, improving reliability.

Reliability was also the prime factor directing the choice of integrated circuits for most of the camera's electronics, though size, weight, power-consumption and cost reductions were also considerations. Of the 43 integrated circuits used, 24 are of different types and 19 of these types were designed especially for the camera.

AUSTRALIANS HONORED

The MSFN Australian tracking stations at Carnarvon and Honeysuckle Creek shared in an achievement award.

Senator Kenneth McColl Anderson, Australian Minister for Supply, formally received a Group Achievement Award for the Department of Supply from the NASA Acting Administrator, Thomas O. Paine.

The citation:

"For its outstanding contributions in the establishment and operation of the stations and associated facilities in Australia which assured the success of the Apollo 8 Mission, the first manned lunar orbit mission which blazed a new trail for mankind into the vastness of extraterrestrial space."

In addition to the above, awards will be given to Sen. Anderson for the two Manned Space Flight Network stations, the Deep Space Network station that served as backup during Apollo 8 and the switching center in Australia. The DSN station and switching center are located near Canberra.

These citations:

"For exceptional support to the Apollo 8 Mission. The dedication of all network personnel and their skill in tracking and maintaining communications and acquiring data assured the success of the first manned lunar-orbit mission."

The *Technical Information Bulletin* is published twice monthly by the Manned Flight Operations Division for Network personnel only. Since information contained herein may not have been released outside the project organization, it is to be considered privileged. Release of this information to others must be approved by the Public Information Office, GSFC. Address other communications to J. Mulvihill, TIB Editor, NASA, Goddard Space Flight Center, Code 820, Greenbelt, Maryland 20771, or use the MSFN teletype facilities.