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TO CATCH A COMET

8954

Technical Overview of CAN DO G-324

HALLEYS COMET
SATELLITE BORNE PHOTOG.
ASTRONOMICAL PHOTOG.
IMAGE PROCESSING

SPACE SHUTTLE MISSION 61-E
CAMERAS
TELEVISION EQUIP.
DETECTION
VIBRATION TESTING
PHOTODIODES
MICROPROCESSOR

MR778932

Edited by

Thomas J. O'Brien
Computer Specialist CSS
Medical University of South Carolina-Department of Family Medicine
Charleston, South Carolina

Contributors:

John Moore, Ed Seabrook (Structural)
Tom O'Brien (Heating, Electrical, MAPC)
Tom Collings (Intervalometers, Computer)
Ralph McCay (Thermal)
Jim Nicholson (Photo, Optical)
David Lee (Software)

INTRODUCTION

The primary objective of the C.E. Williams Middle School Get Away Special "CAN DO" is the photographing of Comet Halley. As it is currently scheduled, G-324 will fly in March of 1986 aboard STS 61-E. The project will involve middle school students, grades 6 through 8, in the study and interpretation of astronomical photographs and techniques. ~~The objectives of these studies are detailed in another paper to be presented at this symposium.~~

G-324 is contained in a 5 cubic foot G.A.S. Canister with an opening door and pyrex window for photography. It will be pressurized with one atmosphere of dry nitrogen. Three 35mm still cameras with 250 exposure film backs and different focal length lenses will be fired by a combination of automatic timer and an active comet detector. A lightweight 35mm movie camera will shoot single exposures at about ½ minute intervals to give an overlapping "skymap" of the mission. The fifth camera is a solid state television camera specially constructed for detection of the comet by the microprocessor. In addition to the photographic goals of CAN DO, the canister also contains a separate package of middle school student designed passive experiments. ~~These projects~~ will be described in detail in the accompanying paper on ~~educational goals~~.

DESIGN PHILOSOPHY

The key word in any design is simplicity. The simpler you can make a working system, the more reliable it is. Particular attention should be paid to good construction practices. A clean neat layout not only looks good, but has a much better chance of working in flight. It's best to start with a basic mission definition and design a simple package to meet that definition. The bells and whistles can come later and they should in no way compromise the basic design by their failure. Use redundant high quality parts whenever possible. This is not the place to skew the cost/benefit ratio too far. Don't overlook a major resource in your Design Reviews, team members of other disciplines. Questions that require explanations of principles and concepts sometimes reveal a flaw that has been overlooked because of familiarity with the design. Perhaps, even a way to simplify it further can be found. When designing redundant protection, it's very easy to get paranoid about remote failures. It's not a black and white issue and the design review process can be most helpful here. You can bet that sooner or later something will fail. The trick is to design the system so the failure occurs after the mission is complete. Preferably LONG after.

With this in mind, we have designed CAN DO with several small independent control subsystems. These can continue the mission at a reduced capacity in the event of most failures short of the door not opening.

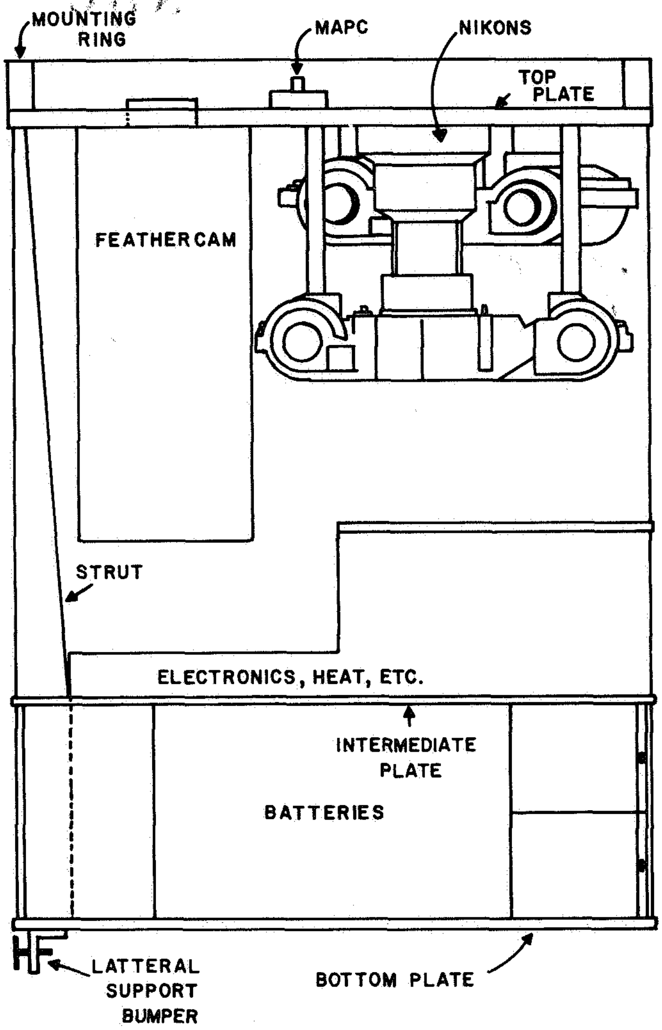

Fig. 1

STRUCTURAL

The G-324 payload structure (Fig. 1) consists of an upper and a lower plate at the top and bottom of the canister, separated by 3 struts. These struts are bolted at 120° intervals on the plates' perimeter. The top plate is bolted to the experiment mounting ring through a spacer ring which has a thermal barrier at the mounting ring and supplies clearance for the insulation and lens openings. The bottom plate will be laterally supported by three adjustable bumpers which will press on the canister wall. The cameras are mounted on the lower face of the top plate and their lenses protrude slightly through the holes in the top plate. Mechanical support for each lens is provided at its opening. The batteries are mounted in four battery boxes. Three are mounted between the struts and bolted to the bottom plate. The fourth is bolted to the top of the intermediate plate. All battery terminals are facing out for easy accessibility. The electronics and electrical systems are mounted on an intermediate plate which forms the top of the battery box assembly and is also attached to the three struts. All structural material is machined from alloy 6061-T6 aluminum. This alloy was chosen for its high resistance to stress corrosion, and it does not require a NASA Material Usage Agreement. Stainless steel bolts and lockwashers were chosen for their strength and compatibility with the aluminum. The stress analysis was done by hand calculation techniques and based on the published ultimate strengths of the material and load factors, as given in the NASA Safety Manual.

Extensive shake and vibration tests are scheduled for the structure with the cameras and batteries mounted before the electronics are added. Additional shake and vibration tests as well as environmental tests are scheduled for the completed canister.

THERMAL AND HEATING

In addition to the standard canister insulation of Dacron, aluminized Kapton and Beta cloth, G-324 will be wrapped in aluminized mylar to form the equivalent of a "vacuum bottle effect" at 0g between the payload and the interior of the canister. The top plate will be insulated from the experiment mounting ring by an insulating ring on top of the 1 3/8" mounting ring to block heat conduction. All through bolts to the experiment mounting ring will also have insulating washers and sleeves to further reduce conductive heat loss.

Due to the insulating effects of the closed lid, thermal loss prior to the actuation of GCD-C (which opens the door) is considered to be at the rate of a container with an insulated lid. This, combined with the large thermal mass of the battery stacks should give us a starting ambient temperature several degrees above 0°C. As seen in Fig. 2 and 3 , the projected mission life at the designed ambient temperature should exceed 30 hours.

The lack of convection at 0g which enables us to form this "vacuum bottle" effect also causes several problems. Since STS-61E is a deep space oriented flight with no sun exposure for the cargo bay, temperatures can effectively form a -70°C heat sink. As a result, we will need to supply at least 22 watts of heat on a continuous basis to replenish the heat lost by conduction and radiation. G-324 has two heaters mounted on a finned heat exchanger and an atmospheric circulation system. If one heater fails, the remaining heater can supply the needed heat to maintain 0°C.

An EG&G Rotron Mil-80 DC fan provides the primary nitrogen atmosphere circulation through the heat exchanger and canister. This primary fan has an integral speed comparator. This comparator switches in an auxillary fan in the event of a low or no speed condition. The reference speed was set below the fan speed running at the projected end of mission voltage level. Circulation volume at the end of the mission will still be more than required for thermal stability.

The dual heaters have both primary temperature and secondary overtemperature thermostatic control. Two paralleled Elmwood 3153 Hi-Rel thermostats with a 2.2°C differential provide a redundant primary temperature setpoint of 0°C. As overtemperature protection, two additional paralleled 3153 thermostats are in series, with a set point at 5.5°C. These will open on a temperature rise in the event a primary thermostat sticks closed with a welded contact.

ELECTRICAL

As seen in Fig. 5, power is supplied from five battery stacks. The four primary stacks supply 28 volts at 156 ma, 24 volts at 105 ma, 12 volts at 220 ma and 12 volts at 3.6 Amps. The fifth stack acts as a redundant source to both the 28 volt and 24 volt stacks through blocking diodes, and likewise, the 24 volt stack acts as a redundant source for the low current 12 volt stack. All battery stacks are isolated from each other by schottky diodes to prevent discharge into lower voltage stacks.

The 28 volt source supplies 60 ma to the door opening circuit and 96 ma to the main power relay. The Leach KD-2A 4PDT relay will drop out at 7 volts. The door will close when the source voltage drops to 24 volts.

The 24 volt source supplies 100 ma to the Matrix Array Photodiode Camera (MAPC) for comet detection, an averaged 25 ma to the Feathercam 35mm movie camera and 1 ma to the Feathercam's intervalometer. The MAPC will operate down to 12 volts and the Feathercam will drop out at 16 volts.

The low current 12 volt source supplies 176 ma to the fan, 40 ma to the microprocessor for detection of the comet and 4 ma to the intervalometers that automatically fire the three Nikon cameras. All loads on this supply will operate down to 5 volts.

The high current 12 volt source supplies 3.6 Amps to the thermostatically controlled heaters. Heat lost from the canister can be replaced by 22 watts of continuously supplied heat. At this rate, 0°C ambient can be maintained in the canister until the battery voltage reached 8.4 volts. At this point, the thermostats remain on and the canister begins to cool. As the temperature drops, the mission will end either by the door closing or thermal shut-down of the cameras.

Schottky diodes were chosen for blocking diodes because of their very low forward voltage drop that, in our application, is on the order of 300mV compared to standard silicon diodes at about 1V or better. Two are paralleled at each location for redundancy. The battery stacks are fused on the negative lead to ground by special Bussman GOV Hi-Rel fuses.

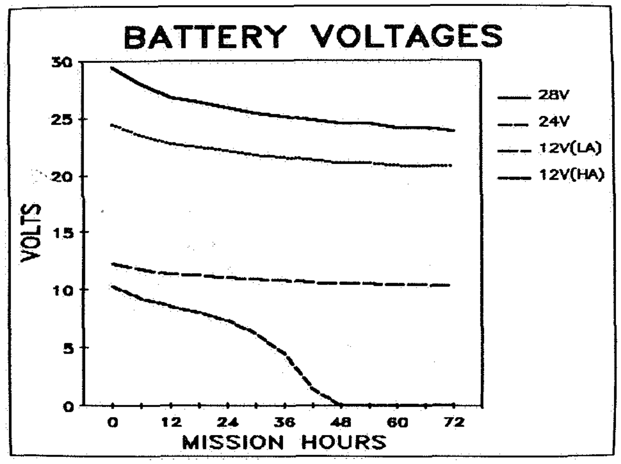

Fig. 2

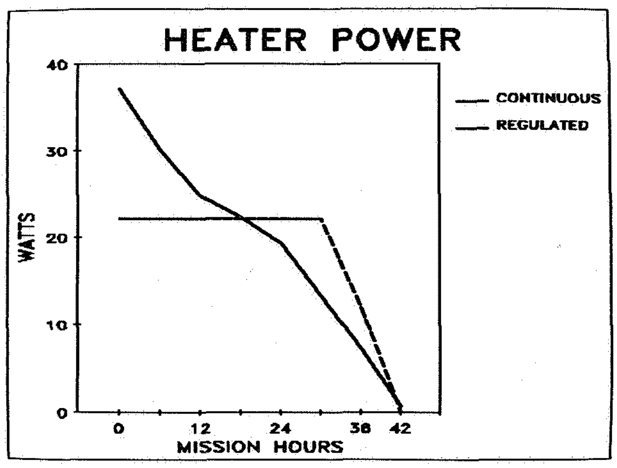

Fig. 3

BATTERIES

The Duracell Industrial Alkaline ID9150-6V and ID9260-12V 20 AH batteries used were extensively tested under expected and stressed conditions. To predict mission life, a set of batteries was chilled to +2°C for 5 days and then discharged through the projected loads for each supply. Graphs of the voltage drop vs. time were then used to estimate mission life and to set photo intervals. In addition, one chilled battery was shorted with two 14 ga. wire straps to determine a direct short hazard. Post-short examination revealed that pressure was released at the cell seal. There was no evidence of swelling of the cell can, so explosion under a direct short is unlikely. Pressure venting seems to occur above 90°C. Several batteries were then frozen to -70°C and showed no evidence of leakage or rupture. They performed quite well when brought up to 0°C. It now appears that the temperature drop due to heat loss and depletion of the heater batteries will determine the length of the mission.

PHOTOGRAPHIC LENSES

Plans for the fulfillment of the primary photographic mission of CAN DO were based on several assumptions. Most challenging were the somewhat disappointing estimates of the brightness expected from Halley on this apparition because of the relatively unfavorable viewing angle and distance from the Earth. In addition, the drift rate of the shuttle itself can not be accurately predicted but will limit the length of exposure possible without unacceptable image streaking. We chose full color pictures which ruled out electronic image intensification as an option. Consequently, tests were designed to find the fastest possible films and lenses that would produce images of adequate quality in a short enough exposure time to minimize shuttle-movement blurring.

After consultation with the National Geographic Society, three lenses were selected for testing and obtained on loan through the courtesy of Nikon Inc. The 35 mm f2 wide angle Nikkor lens with a 65 degree angle of view was selected to be mounted on an intervalometer fired Nikon F3 to provide a wide enough field to include the full visible tail of the comet with enough background stars for adequate mapping. While not the fastest 35mm lens available, NGS's experience indicated that it would give superior results. Our tests verified this impression, and the lens gives a bright, clear image free from noticeable distortion, even at the edges.

Two high speed 58mm f1.2 "Nocturnal" Nikkor lenses were selected for use, one on a Nikon F3 and the other on the Feathercam 35mm movie camera. These lenses were selected for their exceptional speed, their 40 degree field of view, and for their design which is optimalized for full aperture use with high contrast subjects. Astrophotography tests verified the competence of these lenses, and although they show a slight "coma" distortion for extremely bright stars at the edge of the field, this is considered a small price to pay for their exceptional speed.

The final photographic lens chosen was a Nikkor 200mm f2 ED telephoto lens with a 12 degree field of view. Mounted on a Nikon F3, this lens with its narrow field is primarily designed to be fired by the microprocessor when the comet is actually in view. In the event of the MAPC failure, only a small percentage of shots will likely hit the comet. This lens also tested well for astronomical subjects and it is hoped that it will justify its weight and size by returning spectacular "close-up" views of the comet.

MAPC LENS

The hardest lens to find was the imaging lens for the MAPC comet detection solid state video camera. Image quality was not a primary consideration because of the low resolution (32x32) photodiode array, but high speed was, as tests indicated that the predicted brightness of the extended comet would stretch the sensitivity of the chip beyond the maximum design limits. Most difficult was finding a lens with a 20-25 degree angle of view that produced an image small enough to fit the 2.5mm square active area of the array. Early tests indicated that a 10x microscope objective used inverted would produce an adequate image but the f6.3 speed and a bad tendency to flair in the presence of a bright object were disappointing. We have shifted our attention to a Rolyn Optics Coranar series 12mm f1.9 lens. This lens has a 50 degree field of view but overcovers the chip, producing an effective field of view of approximately 20 degrees. It comes in a very tiny (13mm x 12.5 mm) and lightweight (1/2 ounce) package. The size is important as the MAPC camera will be mounted above the main plate to achieve maximum chilling to reduce dark current. An added benefit of this lens is that its relatively fast f2 "photographic" aperture should brighten extended objects like the comet while its tiny 6 mm clear or "astronomical" aperture will suppress point source objects like stars.

CAMERAS

A 35mm format was chosen as being large enough for image quality while being small enough for high capacity. Also considered was the large selection of high speed films available in this format. Nikon F3 High Eyepoint cameras were selected for their proven record in space and were obtained on loan from Nikon Inc., with the support of the National Geographic Society. Each Nikon is equipped with a MV-4 motor drive and a MF-4 250 exposure magazine back. The cameras will be powered by their internal (alkaline AA) battery packs. Tests indicate they have a capacity far in excess of requirements, even allowing for a 90 day waiting period and cold mission temperatures.

In addition to the three Nikons, there will also be one Continental Camera Co. Feathercam 35mm motion picture camera on loan from the manufacturer. This ultra lightweight movie camera has a 400 foot magazine (5000+ 35mm pictures) but is only slightly larger than a typical 16mm camera. Its capacity will allow it to be fired approximately once every half minute throughout the mission.

FILM

It was originally intended that at least two of the many new high speed films now coming onto the market would be flown, one positive and one negative. The films would be selected on the basis of thorough testing . It is beyond the scope for this paper to detail the results of this test, but the information is available on request. In brief, 10 films were selected, including four color slide films (ISO 400-1600), four color negative films (ISO 400-1600), and two black and white films (ISO 400-800). All major manufacturers were represented.

The main test was conducted with the cameras mounted "piggy-back" on a 12 inch Questar telescope equipped with an equatorial drive. The Orion constellation was selected for a target because of its combination of bright and easily identified stars and a prominent nebula to serve as an extended source. In addition it was noted that the Orion region is being used as a calibration standard by the International Halley Watch and other organizations. An evening was found when Orion was well situated against a relatively dark rural sky and near ideal "seeing" conditions prevailed. A complete series of exposures from 1 second to 5 minutes in length were executed with both the 58mm f1.2 and 35mm f2 lenses on each of the ten films. The range of exposure proved adequate for every film to cover the range from gross underexposure to an exposure where the sky "burned in".

All films were carefully developed to manufacturers' standards and then evaluated with a thorough battery of subjective and objective tests. These tests included enlargements up to 40x, microscopic examination for greatest magnitude detected, and evaluation for such criteria as grain, resolution and color fidelity. The most damning test for many films was found to be their inability to produce a dense saturated black background when printed to show the best detail in the stars and nebulae. This criteria, in fact, ruled out all of the color negative materials which were notably inferior in this regard. Surprisingly, the test was won "hands down" by

Ektachrome 800-1600. Even compared to slower films, it produced the best image quality, while easily capturing the title of the fastest color film tested. When enlarged as much as 20 times, this material showed brilliant color against a pure black, seemingly grainless background. The results were so conclusive, in our opinion, that we are going to fly it as our only film. This result is in direct contradiction to several other published reports, including one by NGS. These reports did not include astronomical subjects as part of their tests. We feel this emphasizes the necessity of conducting your own test under the particular conditions you will encounter. You should not rely on tests conducted by others, which may be irrelevant to your application.

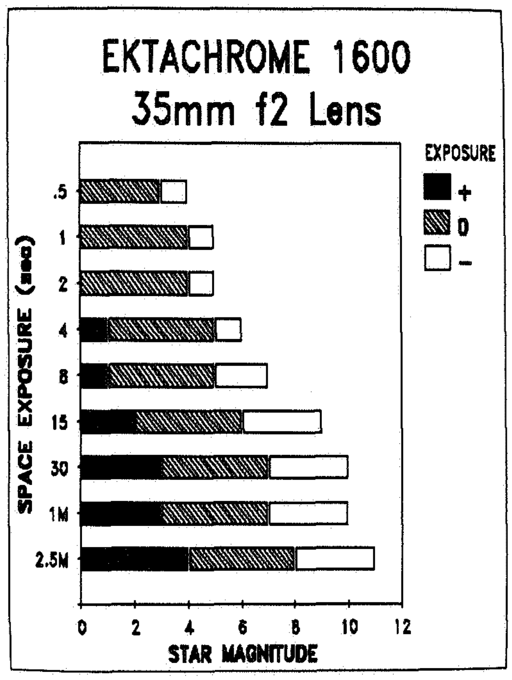

Fig. 4

Table 1

FILM TEST SUMMARY

FILM	SCORE
Ektachrome 1600	68
Ektachrome 400	52
Fujichrome 400	50
Kodacolor 1000	48
Agfacolor 400	48
Ilford XP-1	42
Fujicolor 1600	41
Kodak Tri-X Pan	41
Agfacolor 1000	40
Agfachrome 1000	35

Scoring System

Film Speed	(2-8) pts.
Sensitivity (1 sec). .	(1-5)
Sensitivity (15 sec) .	(5-8)
Range.	(2-5)
Resolution	(0-9)
Color.	(3-9)
Grain.	(3-9)
Black Sky.	(1-9)
Print Quality.	(1-9)

EXPOSURE

The photographic tests were also used to determine exposure times for the mission. It has proven difficult to get complete information on either the expected brightness of the comet, or the predicted drift rate of the orbiter. The final exposure will be set closer to flight time and will be based on the latest available information. At present, we are considering a baseline exposure of 10 seconds for the f1.2 lenses, and 15 seconds for the f2 lenses. These exposure times are felt to be the best compromise between adequate exposure to show significant tail detail while being short enough to minimize drift problems. This baseline exposure will be used for all "automatic" intervalometer fired photos. The same time will also be used for the first shot taken by the "smart" cameras in each comet window. Each additional photo taken during active MAPC comet detection will be doubled in time to produce more detail in the dimmer reaches of the tail, and to avoid unnecessary duplication. The final maximum exposure will be determined by the actual length of the comet window but it could reach as long as 10 minutes in the several 30+ minute windows currently shown in the Astro 1 mission profile. There is a relatively small chance that these extremely long exposures will not be spoiled by drift, but if successful, they will produce the most significant photos of the comet tail structure. The opportunity to obtain such photos is solely dependent on the ability of the MAPC detector to determine when the comet is, in fact, in the proper line of fire. This justifies the considerable effort in designing a system to add some 200-300 aimed shots to the possible 1100 shots of the comet which may be obtained by intervalometer alone. This figure, based on scheduled window time, is misleadingly encouraging because most of these photos will be nearly exact duplicates of each other and will offer little new information.

INTERVALOMETERS

In the pursuit of redundancy, each camera is controlled by its own independent timer or intervalometer. This allows both the interval time (the time between pictures) and the exposure time (the duration) to be "programmed" by simply changing a resistor value. Each intervalometer is composed of three integrated circuits. The 4060 functions as a multivibrator whose frequency is set with two resistors and a capacitor. This oscillator runs at a few hertz using small RC values. Because the chip also contains a divide by 16,384 counter, the output changes only every 15 to 30 minutes. This allows accurate timing into the hour range. Its output is used to trigger a 7555 which is operating in a monostable or one-shot mode. When the 7555 is triggered, its output becomes active until the exposure time is complete. This time is a function of its R.C. values. The output is buffered and inverted by a 74C04 which controls the camera shutter directly. All of the timers are held in the reset condition while the door is closed. The 74C04 is replaced with a 74C02 in two of the intervalometers which allows either the sequencer or the Image Recognition Computer to fire the cameras and determine the exposure time.

MAPC

The heart of the MAPC or Matric Array Photodiode Camera is an EG&G Reticon RA32x32A imaging chip. This chip has 1024 photodiodes arranged in a 32 by 32 array. Each photodiode is one small picture element or pixel. To run the array chip, a crystal controlled master clock oscillator of 4.9152 mhz is divided by 512 to produce a 9.6 khz clock. This clock is used to encode the data output for transmission to the Image Recognition Computer. It is further divided by 2 and the resulting 4.8 khz is gated to suppress every fifth pulse. This fifth pulse pause is used to insert the start and stop bits in the digital output. The gated 4.8 khz clock drives the sample and hold stage, digital latch and the X register of the RA32x32A. One pixel is clocked out of the array for each gated clock cycle. At the end of each line of pixels, a flag advances the Y register to the next line. As each group of four pixels is clocked out, they are buffered and sampled by the sample and hold stage. Each pixel level is held while it is converted to a 2-bit digital value. This value indicates four distinct video levels or picture brightnesses, white - gray - black and "blacker than black" or blanking. Each group of four Pixel values is then combined with a start and stop bit to make a digital word. The 10-bit words are transmitted serially at 9600 baud to the microprocessor along with a separate "start word" flag. At the end of each line and at the end of the field, a flag is sent to the Image Recognition Computer by transmitting a blanking bit pattern in place of a dummy pixel in the data stream. There are two dummy pixels provided at the end of each line for housekeeping, both in the chip and by the user. One blanking group indicates the end of the line (EOL) while two in a row indicates the end of the field or picture (EOF). These are used by the Image Recognition Computer to reconstruct the image for comet detection. Power from the 24 volt stack is pre-regulated to +12 VDC by a linear monolithic regulator. This feeds a +5 VDC and +7 VDC regulator as well as a DC-DC converter. The converter operates at 10 khz using a Siliconix Si7661 CMOS voltage converter to supply the -7 VDC needed by the camera.

IMAGE RECOGNITION COMPUTER

The Image Recognition Computer is built around the NCR 65C02 microprocessor. This processor was chosen because it is simple to program and the Apple II computer could be used as a development system, once a monitor and interface program were completed. The system is designed to have 8K of memory in blocks of 2K each. The memory can be static RAMs (61L16s) or EPROMs (2716s). The firmware program, once completed, will reside in EPROM at the top of the 8K memory space. The main scratchpad memory starts at location zero. For program development, the EPROM is replaced by RAM. After the program is edited and assembled on the Apple, it is downloaded at 4800 baud to RAM and debugged. The interface to the Apple and the cameras is through the NCR 65C22, an interface IC with two eight bit ports and two timers. To isolate the cameras from any possible computer malfunction, the controlling signal from the NCR 65C22 triggers a monostable multivibrator (7555) instead of the cameras directly. This allows the camera to fire only once in a given period of time. The end of the exposure is signaled by the 65C22 resetting the monostable. A "heartbeat" circuit is also installed to assure correct operation of the processor. This circuit will reset the processor every 30 seconds if the processor "gets lost" for whatever reason, and continue to reset until the program starts again. The circuit is composed of a 7556 dual timer. The first timer operates in the monostable mode while the second timer is in the astable mode.

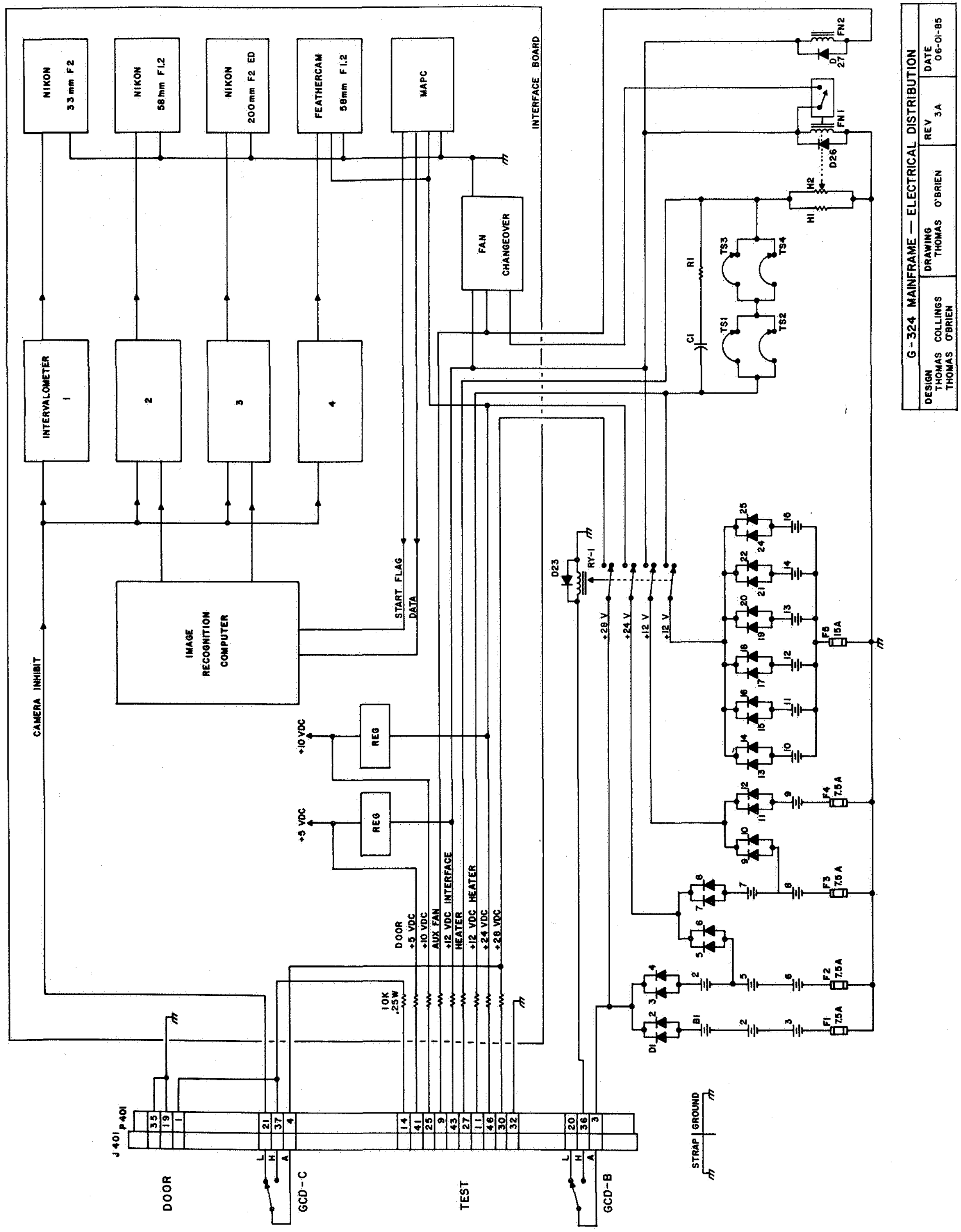
NIKON 33 mm F2
NIKON 58mm F1.2
NIKON 200mm F2 ED
FEATHERCAM 58mm F1.2
MAPC
INTERFACE BOARD
FAN CHANGEOVER
INTERVALOMETER 1
2
3
4
IMAGE RECOGNITION COMPUTER
START FLAG
DATA
CAMERA INHIBIT
REG
REG
+10 VDC
+5 VDC
DOOR
+5 VDC
+10 VDC
AUX FAN
+12 VDC INTERFACE
HEATER
+12 VDC HEATER
+24 VDC
+28 VDC
10K .25W
J401
P401
35
19
1
21
37
4
14
41
25
9
43
27
11
46
30
32
20
36
3
L
H
A
DOOR
GCD-C
TEST
GCD-B
STRAP GROUND
D23
RY-1
+28 V
+24 V
+12 V
+12 V
D1
B1
F1 7.5A
F2 7.5A
F3 7.5A
F4 7.5A
F5 15A
TS1
TS2
TS3
TS4
R1
C1
H1
H2
D26
FN1
D27
FN2
G-324 MAINFRAME — ELECTRICAL DISTRIBUTION
DESIGN THOMAS COLLINGS THOMAS O'BRIEN
DRAWING THOMAS O'BRIEN
REV 3A
DATE 06-01-85

Fig. 5

SOFTWARE

The software is divided into four areas or routines: data acquisition comet detection, system maintenance and a run-time system. The data acquisition routine is responsible for reconstruction of the image from the MAPC. After reception, the end of line and end of field flags used in the reconstruction are removed, and the image is passed to the comet detection routine.

The algorithims for digital image processing and pattern recognition will be emperically defined using simulated comet images in planetariums at South Carolina State University and the University of North Carolina. Our present research has centered on the use of a simple neighborhood averaging filter to suppress isolated bright values (stars) while reinforcing diffuse bright objects (comet). This is followed by a simple pattern recognition algorithm which checks for the presence of a large, relatively homogenous, bright object having a recognizable axis which is significantly brighter than the surrounding background. This simplistic routine is possible because no other astronomical target, including the sun and moon, is larger than .5 degrees, while the comet should cover at least 10 degrees. Possible sources of false positives could be the Milky Way or the illuminated edge of an approaching Earth sunrise. The Milky Way should be suppressed by the small "astronomical" aperture of the imaging lens and its spotty brightness variations should make it relatively susceptible to the averaging filter. No special protection has been planned against a terrestial false positive as little or no Earth viewing time is scheduled in the current mission profile.

When the comet detection routine indicates that the comet has been acquired, the shutter control subroutine will proceed with an exposure sequence. This controls the shutters on the 58 and 200mm Nikons by generating pulses on two separate pins of the NCR 65C22. One will open the shutters by starting a monostable multivibrator while the other closes them by resetting it. The multivibrator will automatically reset after ten minutes if the computer should fail, returning control to the intervalometers.

System Maintenance software includes initialization routines, a real time clock and the Run Time System. At power up or after a reset cycle, the initialization software configures the timers and I/O ports, initializes the symbol table, starts the real time clock and finally enables interrupt requests. The real time clock is driven by timer T1 on the NCR 65C22. A countdown timer which pre-sets to 50,000 will request interrupts at 20 Hz. Counting these 20 Hz "ticks", the real time clock will maintain the seconds, minutes, and hours registers.

The Run Time System is an executive program, responsible for calling the acquisition and processing routines. It also monitors the system for error conditions and takes corrective measures. The Run Time System is responsible for generating the "heartbeat" pulse on one pin of the output port which indicates that the microprocessor has bootstrapped successfully, and that the software is functioning. Should the software fail (unsuccessful bootstrap, trapped in a loop, interrupt thrashing, etc.), the Run Time System would no longer produce the heartbeat. An external resetable multivibrator will sense the loss of the heartbeat and initiate a processor reset cycle and continue to reset until the heartbeat is recovered. The Run Time System can also detect failure modes in data transmission, image processing and film use.

POSTFLIGHT IMAGE PROCESSING

The CAN DO team is fortunate to have access to a Zeiss IBAS image processing and analysis system for postflight image enhancement and evaluation. We have included this potential in designing our photographic parameters. Most likely to be useful will be digital processing to suppress photographic grain, to mask excess contrast, to enhance faint detail, and to remove image streaking if necessary. If MAPC directed exposure series are available, we will use this apparatus to construct composite true color and density graded false color images of the comet. It will, in addition, be possible to conduct accurate astrometry measurements of comet structure using background stars for scaling.

FLIGHT DATA RECORDER

The original design included a separate microprocessor with non-volatile RAMs to serve as a flight data recorder. It was intended to record information to assist in photograph evaluation including camera firing times and sample digitized MAPC images. In addition, temperature and voltage data were to be logged to produce general information on the operation of a glass lid canister in an extremely cold (constant deep space orientation) environment. This independent microprocessor became a victim to the great weight purge following the very belated discovery that there is a 45 lb. weight penalty imposed on the use of an opening lid with the pyrex window.

Flight data recording functions in the final configuration will be handled as a secondary function of the image recognition computer.