# DISPLAY PROCESSOR FOR IMPROVED APOLLO TV CAMERA

Final Report

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Summary

The display processor for the improved APOLLO TV camera was shipped from the Westinghouse Research Labs on September 24, 1969. The delay in shipping was caused primarily by a mishap which resulted in considerable damage to the machine and secondarily by the correction of flaws in performance discovered during testing and calibration. Further, it was considered necessary to repeat all of the test and calibration that had been carried out before the mishap so that any damage caused by the accident would be certain to be detected. All of the defects and deficiencies that were discovered in this comprehensive testing program were completely cured and some additional test equipment used in the program, was mounted permanently in the recorder to simplify future test operations.

## Description of the Test Results

Primary test results indicated that use of a disc with surface non-uniformities less than that of the specially selected disc would provide slightly enhanced results. As a consequence, since the supplier from whom a more uniform disc had been ordered was unable to meet the required specification, discs chosen from among the best measured were reformed in order to reduce the effect of any warping. This procedure resulted in a disc having a peak-to-peak run out on both sides of less than 0.5 mil - an improvement of 65%.

During the testing program it was determined that when a complete field was written on any track the join in the recorded FM waveform (that is, the point in the play-back waveform where the recording process was started and stopped) gave rise to a voltage spike in the demodulated waveform. Although this spike does not affect operation in normal circumstances it is felt that, since some forms of equipment make use of pulse counting techniques in processing video waveforms, the presence of this spike might occasionally cause faulty operation. As a consequence, a suppression circuit was added to the recorder equipment to eliminate this spike in the recorded waveform.

During the testing program it became evident that the original design of the FM channel equalizer was somewhat marginal in that the high frequency boost required for amplitude equalization caused severe harmonic distortion problems in the low frequency signals which are rich in harmonics. As a consequence, the equalizer was redesigned to yield a better compromise between amplitude equalization and harmonic distortion.

During test of the timing stability of the system, it was determined that drift in the commercial power supply used for the power amplifier and motor drive could contribute significantly to long term drift problems and worsen the timing accuracy. As a consequence, modifications were made in the servo circuitry which reduces the effect of a change in supply voltage by one order of magnitude, that is, a power supply variation of $\pm$ 1 mV is reduced to $\pm$ 100 $\mu$V at the motor terminals.

Finally it was determined during worst case analysis and test that certain combinations of transistors could give rise to parasitic oscillations at about 200 mc/s in the video output buffer amplifiers. Although the particular combination of transistors parameters required to cause this oscillation may never be present in any of these circuits, it was felt that the design should be replaced in order to prevent oscillation. The new circuits which were used as replacements have adequate protection against these parasitic oscillation problems.

Following these modifications the machine performed up to specification in all respects. However, during the stability measurements the timing jitter was observed to fall outside the required performance range by about 20% for a short period. This effect did not recur during long observations and the cause is therefore uncertain. The stability was measured however, using as an absolute timing reference a relatively inexpensive, commercially available oscillator which it is felt may have been the cause of a large proportion of the timing jitter.

A few days prior to intended shipment the disc recorder became top heavy as a result of a combination of circumstances. The power supply chassis which normally provides a counter balancing force had been removed for final tightening down of components and cleaning. With the equipment drawers extended the machine toppled over. Some damage occurred in the form of broken circuit boards and connectors. Replacement of the damaged parts and subsequent repeat of the entire test program caused some delay in the delivery.

In view of the signal-to-noise ratio test requirements a video level generator withmanual adjustment capability was included in the video disc recorder. Further,

an odd field selection circuit was added to the other test facilities to simplify channel response comparisons. Finally, a circuit board was included in the machine which provides a repetitive command to record pulse which can be used to test the cross talk between writing and reading channels. All of these test features have been permanently wired into the display processor and should serve to simplify considerably, test and calibration of the machine. A number of circuit board extenders and extractors as well as, special extension cables have been provided in the machine to aid in future servicing.