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FAA TECHNICAL CENTER LETTER REPORT

EFFECT OF PULSE INTERFERENCE ON ASR-8 VIDEO PROCESSING MODES

by

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INTRODUCTION

PURPOSE

The purpose of this testing was to investigate the abilities of the Federal Aviation Agency's Airport Surveillance Radar (ASR)-8 radar processors to reject or suppress non synchronous interference.

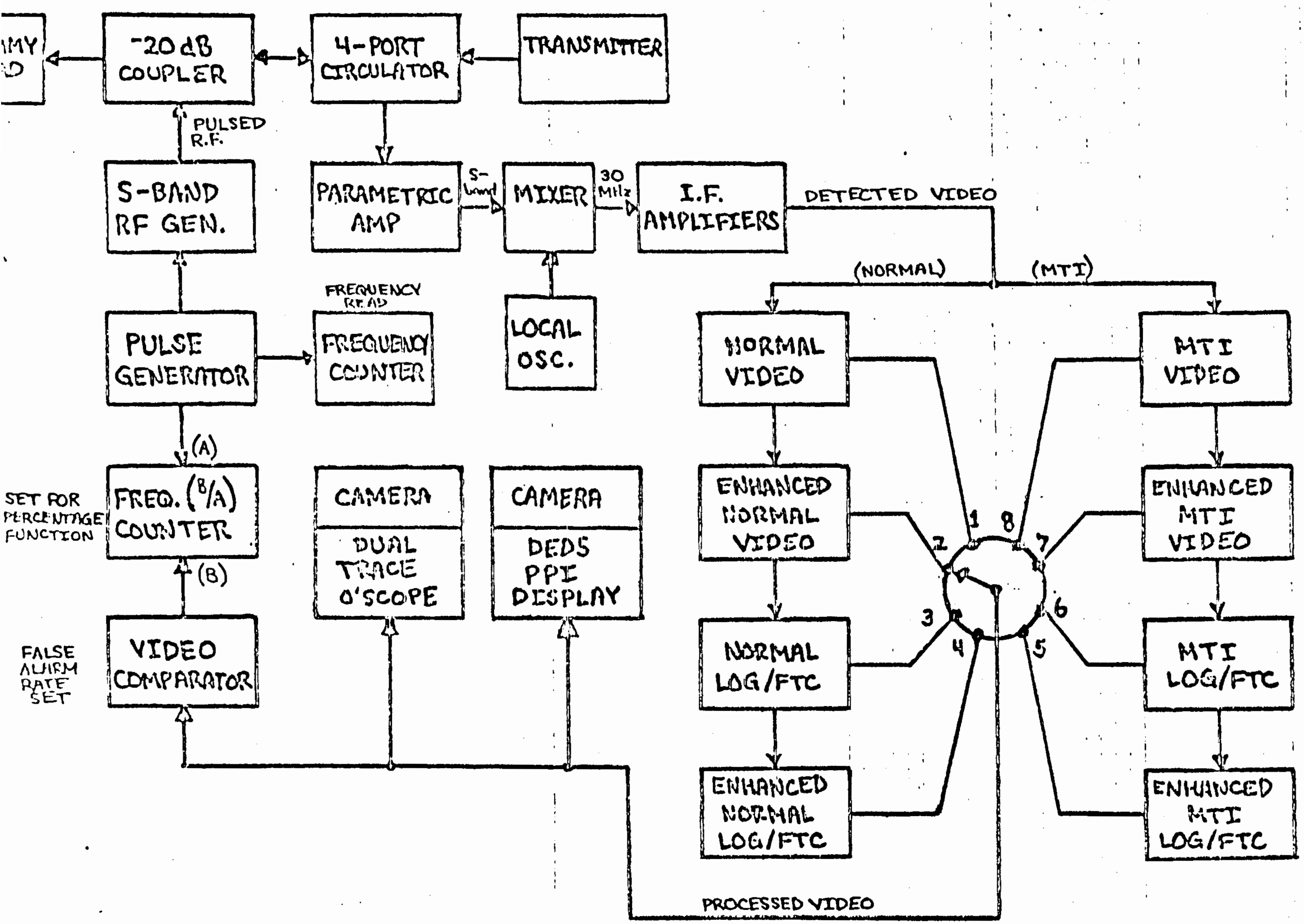
BACKGROUND

The 2700-2900 MHz frequency band is becoming increasingly crowded as additional S-Band radars are placed into operation by the Department of Defense, Department of Commerce, and the Department of Transportations' Federal Aviation Administration. This crowding has led to concern that the performance of the FAA's ASR's is being degraded. Of particular concern is interference caused by the National Weather Service radars which have the capability of operating with pulse widths of either 0.5 usec or 4 usecs. Also, with development of the next Generation Weather Radar (NEXRAD) by the FAA, Air Force, and National Weather Service, additional crowding is expected. In response to this concern, the FAA Systems Research and Development Service has requested that the FAA Technical Center perform an engineering evaluation of the effects of interference on the performance of ASR-8 video processing.

DESCRIPTION OF EQUIPMENT

The Technical Center's Terminal Facility for Automated Systems Testings (TFAST) ASR-8 radar system was used for this testing. The system was configured to represent normal field operation. Test equipment was used to generate the required pulses and to measure the systems' responses described in the following sections. A block diagram of the ASR-8 and the test equipment used is shown in Figure 1. The ASR-8 system was connected to the dummy load so only radio frequency (rf) pulses from the S-band generator (set to the ASR-8's assigned frequency of 2790 MHz) were present. The resulting video output from the processor mode being tested was thresholded in the video comparator to achieve an approximate 1×10^{-6} false alarm rate which provided good sensitivity and repeatability. The comparator output was then compared to the interference pulse generator output to determine the processor's interference rejection capability. Photographic data was taken periodically to aid in the analysis.

FIG. 1 SYSTEM TEST BLOCK DIAGRAM



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GENERAL

The ASR-8 system was tested to determine its ability to reject interference in three categories. These were non synchronous interference, near synchronous interference, and interference synchronous with one of the ASR-8 pulse repetition frequencies (PRF) when it is operated in the staggered transmitter pulse repetition frequency mode.

Each of these series of tests is described in the following sections. Testing was conducted in accordance with the project plan, report number DOT/FAA/82-37.

NON SYNCHRONOUS INTERFERENCE

In this series of tests, the ability of the ASR-8 enhancers to reject non synchronous interference when the radar was operated in its various video processing modes was determined. The video modes tested were enhanced normal, enhanced normal log fast time constant (FTC), enhanced moving target indicator (MTI), and enhanced MTI log FTC. Limit level interference pulses with widths of 0.5, 1.0, 2.0, and 4.0 microseconds and at rates of from 100 to 1200 pulses per second were introduced into the system as shown in Figure 1 and the resulting number of pulses at the output of the processor under test recorded. The radar was operated in the stagger mode.

The results of this series of tests showed that the ASR-8, when properly aligned, completely rejects non synchronous interference except when the MTI system was operated in the feedback mode. In this case, the extra pulses produced in the feedback loop are integrated up in the enhancer resulting in the interference pulses being displayed. This is a known problem with the ASR-8 system for which no correction has been implemented to date.

When tested with a wide (4 microseconds) pulse, the normal and MTI log FTC circuits produced two output pulses for each input pulse corresponding to the leading and trailing edges of the pulse. The enhancer circuits were effective in eliminating both pulses. However, since this led to a doubling of the interference output rate when the radar was operated in the non enhanced mode, a study was made to determine at what input pulse width two output pulses were produced. The input pulse width was increased from a width of 0.5 microseconds and the log FTC pulse outputs were viewed on an oscilloscope. At the point where two distinct output pulses were first produced, the input pulse width was recorded. For the normal log FTC, normal log FTC enhanced, MTI log FTC, and MTI log FTC enhanced modes of operation pulse doubling occurred at minimum pulse widths of 3.0, 5.0, 3.0, and 3.5 microseconds respectively.

NEAR SYNCHRONOUS INTERFERENCE

For this series of tests, the radar was operated in the non staggered mode with a PRF of 1030.7 Hz and the ability of the enhancers in the normal, normal log FTC, MTI, and MTI log FTC modes or operation to reject near synchronous interference was examined. The interference pulse (0.5 microsecond pulse width, receiver limit level amplitude) rate was first varied from below to above 1030.7 Hz and the width of the non rejection band was measured. The results of this series of tests are as follows:

Processor Video Mode	Width of Non Rejection Band (Hz)
Enhanced normal	1030.3 - 1031.3
Enhanced normal log FTC	1030.0 - 1031.2
Enhanced MTI	1029.6 - 1033.1
Enhanced MTI log FTC	1030.0 - 1031.3

The above data shows that the ASR-8 has a good ability to reject near synchronous interference. Only interference at pulse rates close enough to the radar PRF to result in the interference signals being range synchronous from one radar pulse to the next resulted in a system output.

The test generator was then set to produce pulses at rates corresponding to subharmonics of the radar set PRF and the ability of the enhancers to reject the interference was measured. The results of this series of tests are as follows:

Processor Video Mode	Width of Non Rejection Band (Hz)	
	1st Subharmonic	2nd Subharmonic
Enhanced normal	515 - 516	257.7
Enhanced normal log FTC	513.8 - 516	257 - 258.5
Enhanced MTI	514.5 - 517	257 - 259
Enhanced MTI log FTC	513.8 - 516	257 - 258.5

In the above tests, the ASR-8 showed a good ability to reject near synchronous interference incident at rates equal to subharmonics of the system PRF.

INTERFERENCE SYNCHRONOUS WITH A STAGGERED PRF

For this series of tests, the radar was operated in the staggered PRF mode and the interference generator was set to produce pulses with 0.5 microseconds widths, with receiver limit level amplitude, and with PRF's of 1030.7 Hz (one of the four ASR-8 stagger rates and the system average stagger rate) and 1040 Hz (non synchronous for comparison purposes.) The capability of the normal, normal log FTC, MTI, and MTI log FTC enhanced video modes to reject the interference was then measured. The results of these tests are as follows:

Processor Video Mode	Number of Interference Pulses Out/Pulse In	
	1030.7 Hz	1040 Hz
Enhanced normal	3.0	0
Enhanced normal log FTC	3.0	0
Enhanced MTI	3.0	0
Enhanced MTI log FTC	3.0	0

The above data shows that for the synchronous case (1030.7 Hz) the enhancers output 3 interference pulses for each input pulse. Since the chosen interference rate (1030.7 Hz) was at the average ASR-8 system pulse repetition rate, the interference pulses were range synchronous from one radar pulse to the next and therefore integrated in the enhancers resulting in the increased rate. In this mode of operation, two of the four staggered synchronous interference pulses are range coincident and only three synchronous rings of interference are produced and displayed. For the other three pulse repetition rates which are not equal to the average system pulse repetition rate, the enhancers eliminated the interference as it was not range synchronous. For the 1040 Hz (non synchronous) case the enhancers effectively eliminated the interference.

SUMMARY OF RESULTS

The ASR-8 video enhancers eliminated non synchronous interference, except when the system was operated with the MTI cancellers in the feedback mode, and were effective in eliminating near synchronous interference.

Interference synchronous with the ASR-8 average pulse repetition rate (radar operated in staggered mode) resulted in three system output pulses for each interference pulse.

CONCLUSIONS

The ASR-8 system is effective in eliminating interference except when the MTI cancellers are operated in the feedback mode or when the interfering source is synchronous with the ASR-8.

RECOMMENDATIONS

The pulse repetition rates of radar sets operating in geographical proximity to ASR-8 radars should be allocated so as to avoid synchronous interference.

An investigation should be performed to modify the ASR-8 MTI cancellers to provide non synchronous interference rejection when operating in the feedback mode.