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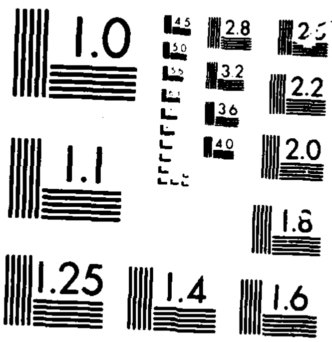
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APPLICATION OF THE AIPA TO F-106 DATA

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J.T. Cordaro

University of New Mexico
Albuquerque, New Mexico 87131

June 1986

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Final Report

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This technical report has been reviewed and is approved for publication.

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Multiple data set reduction
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Approximate iterative preprocessing algorithm (AIPA)

19. ABSTRACT (Continue on reverse if necessary and identify by block number)

This report covers the application of the AIPA numerical algorithm to measured data from the F-106 fly-by electromagnetic pulse test conducted at the AFWL in 1984. The algorithm was partially successful at reducing the data. The amplitudes of the normalized coupling coefficients for the first three poles were determined.

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We looked at 32 fly-by (Ref. 1) data sets from 3 different locations (fuselage, left wing, and right wing) for 4 different directions of incidence (nose on, left wing on, tail on, and right wing on). The sampling rate was 10 ns for every data set.

Out of 32 data sets, only 6 data sets from the fuselage show consistency in the first 3 pole-pairs (Fig. 1). Plots of these six data sets are shown in Fig. 2. Plots of the Fourier transform magnitude of each waveform are shown in Fig. 1. Note that there is a DC-bias in some waveforms. This was corrected before computing a spectrum. We also omitted the first few time samples in an attempt to remove some of the incident field.

Before applying the pole-finding algorithm, each waveform was passed through a second order digital Butterworth lowpass filter with a 20 MHz cutoff frequency. The number of data points used was 90. The approximate iterative preprocessing algorithm (AIPA) (Ref. 2) for multiple measurements was applied for six data sets. The first couple of pole-pairs were successfully extracted by processing all six data sets at the same time.

Pole #1: $\alpha_1 = -6.715 \times 10^6$ $\quad f_1 = 6.803$ MHz

Pole #2: $\alpha_2 = -8.602 \times 10^6$ $\quad f_2 = 11.509$ MHz

The number of iterations required for convergence was less than 10.

The third pole-pair was extracted by processing data sets for left wing on and right wing on. When the order was 6, the result was as follows:

---

1. Lee, K. S. H. et al., "Preliminary Comparison of F-106B Responses to Natural Lightning and Simulated NEMP," Air Force Weapons Laboratory, Heart Conference, Summer 1985.

2. Park, S., and Cordaro, J. T., Preprocessing Techniques for the Estimation of Parameters from Noisy Transient Data, AFWL-TR-85-102, to be published.

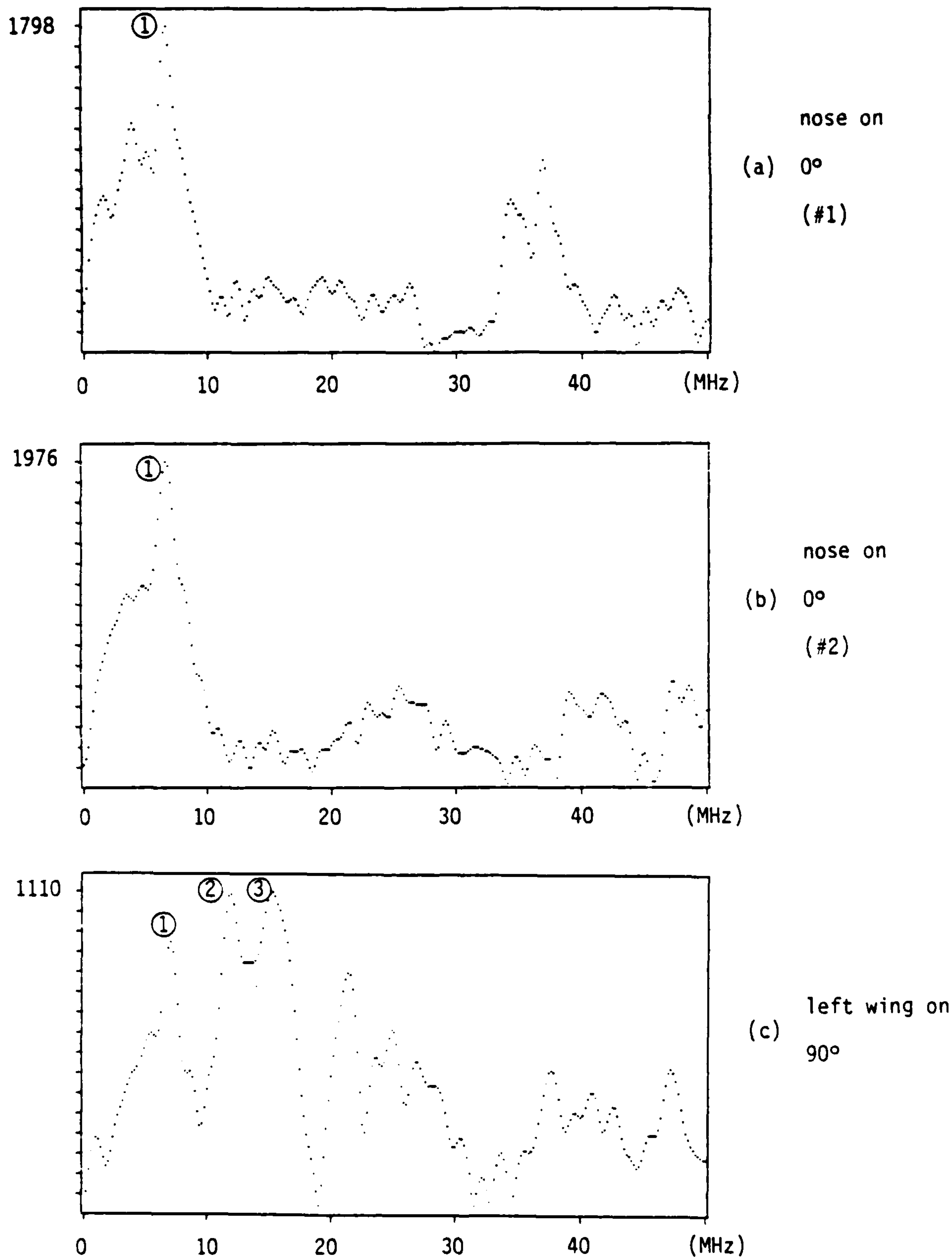
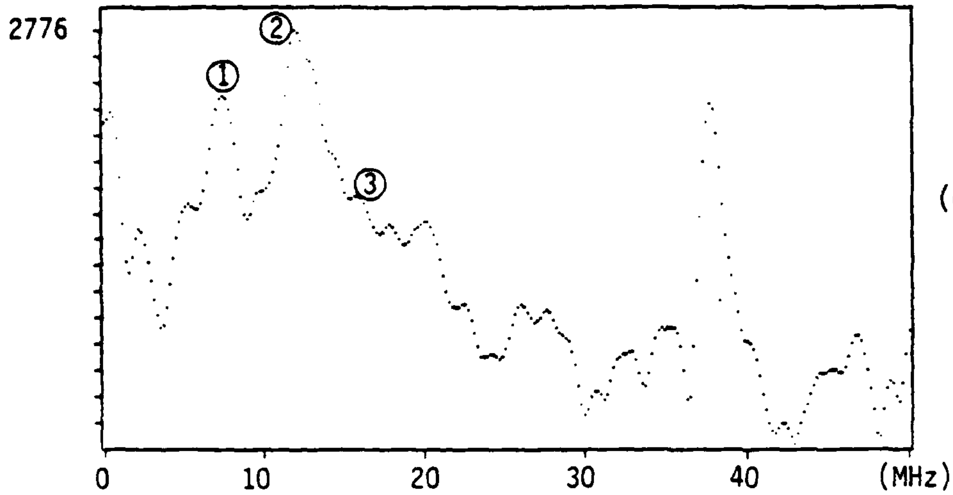
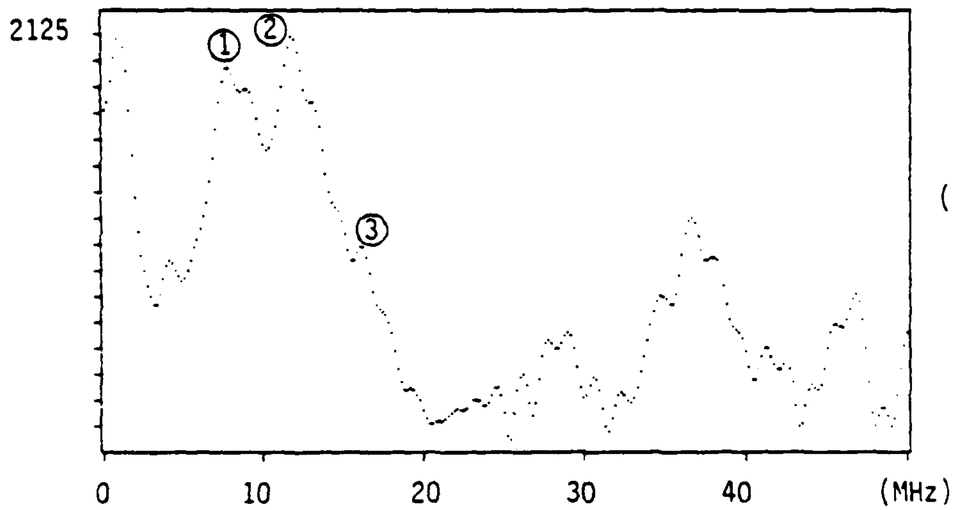


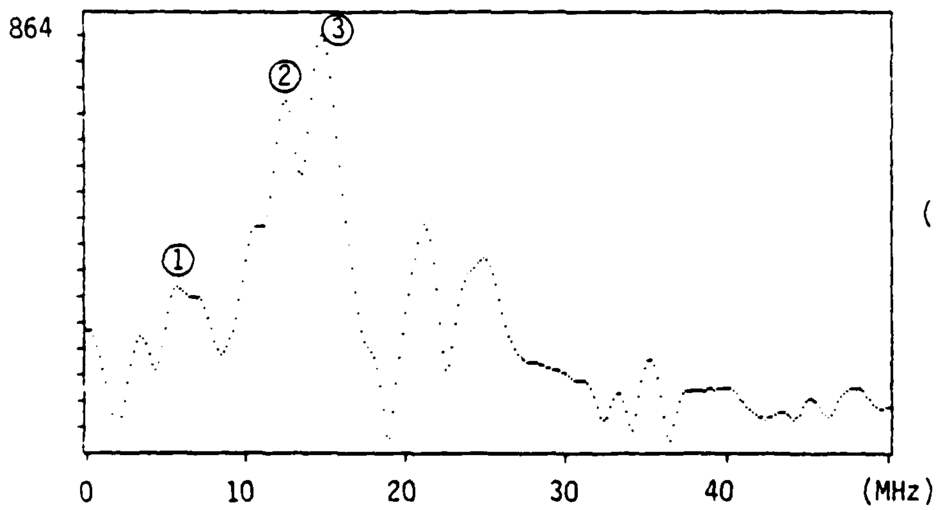
Figure 1. Plot of spectrums.



(d) tail on 180° (#1)



(e) tail on 180° (#2)



(f) right wing on 270°

Figure 1. Concluded.

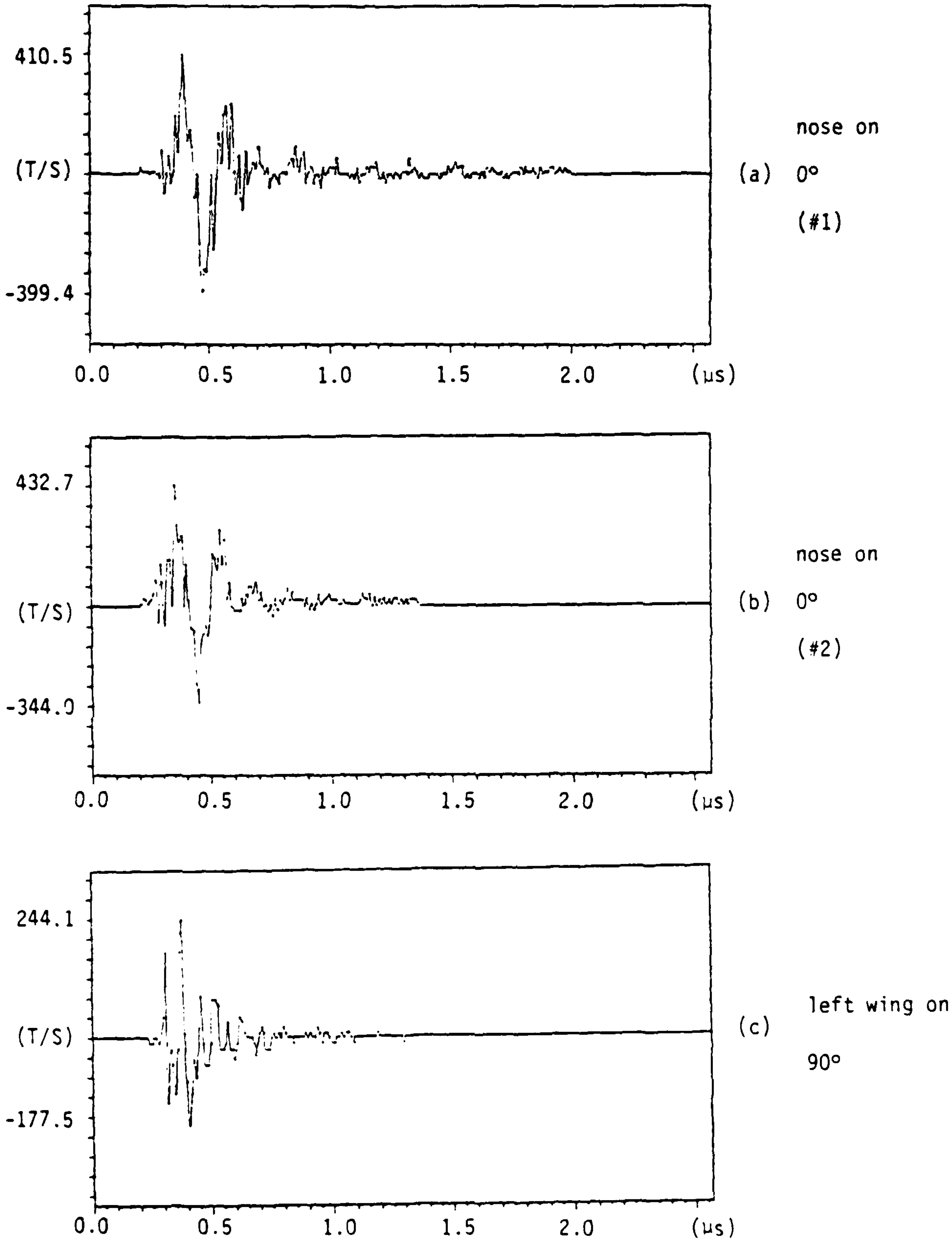
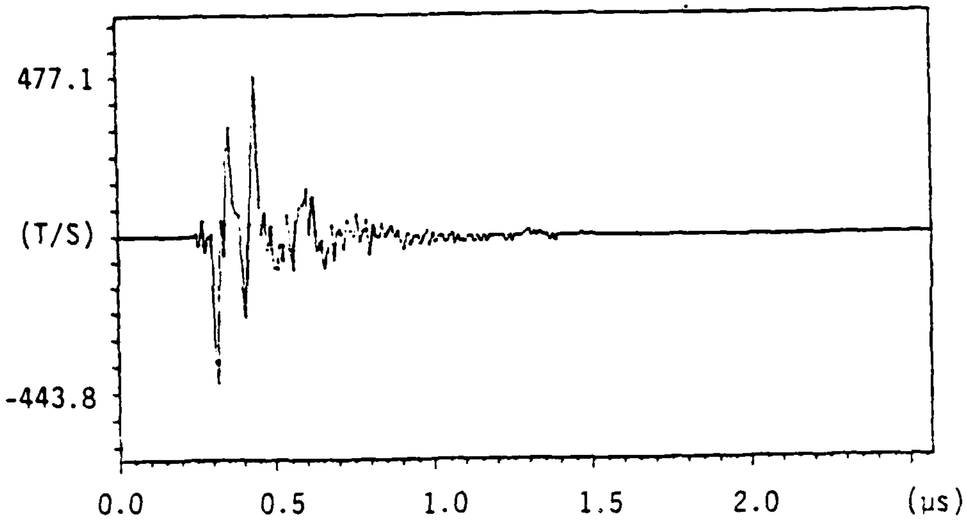
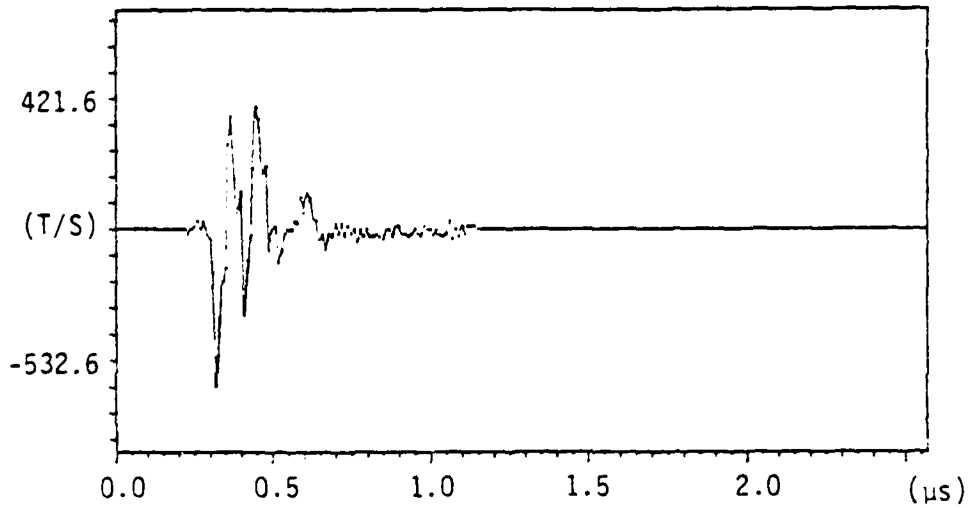


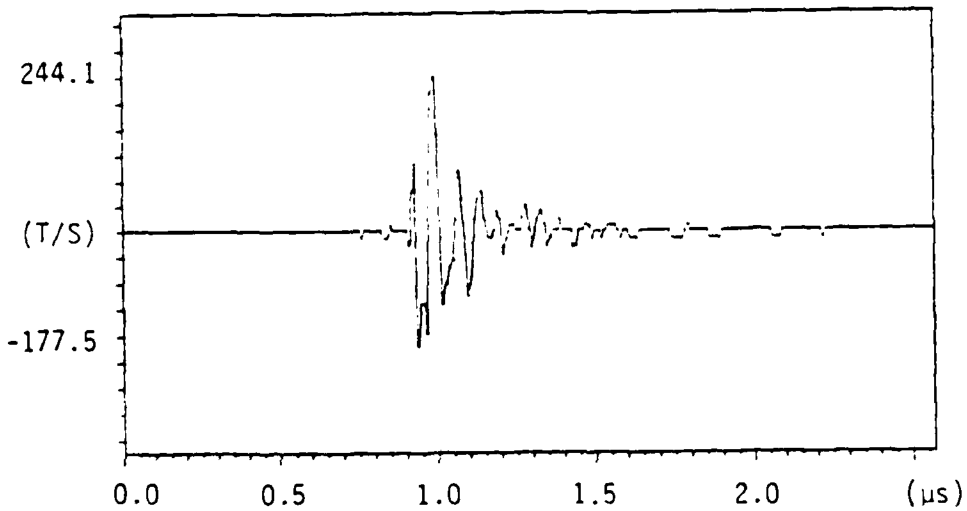
Figure 2. Plot of waveforms.



(d) tail on 180° (#1)



(e) tail on 180° (#2)



(f) right wing on 270°

Figure 2. Concluded.

$\alpha_1 = -8.263 \times 10^6$ $f_1 = 6.043$ MHz

$\alpha_2 = -7.334 \times 10^6$ $f_2 = 11.625$ MHz

$\alpha_3 = -6.423 \times 10^6$ $f_3 = 15.457$ MHz

When the order was 8, the result was as follows:

$\alpha_1 = -7.653 \times 10^6$ $f_1 = 6.091$ MHz

$\alpha_2 = -8.082 \times 10^6$ $f_2 = 11.567$ MHz

$\alpha_3 = -6.656 \times 10^6$ $f_3 = 15.281$ MHz

$\alpha_4 = -3.123 \times 10^6$ $f_4 = 19.914$ MHz

Because the fourth pole-pair was not numerically stable, we selected the third pole as:

Pole #3: $\alpha_3 = -6.656 \times 10$ $f_3 = 15.281$ MHz

Using the algorithm presented in Chapter 7 (Ref. 2), the amplitude of the normalized coupling coefficients for the first three poles were calculated. These are shown in Fig. 3.

Theoretically. the amplitude of the normalized coupling coefficients for 90 deg (left wing on) and 270 deg (right wing on) should be the same (by symmetry); but the plots in Fig. 3 do not show exact symmetry--although plot (c) is close. Only one data set for each wing on orientation was available. Also, the transform amplitudes for poles 1 and 2 at 90 deg and 270 deg are quite different as can be seen in Fig. 1(c) and (f). As a result, the expected symmetry was not found. This could be due to experimental error: for example, the aircraft may not have been positioned exactly wing on for these particular shots.

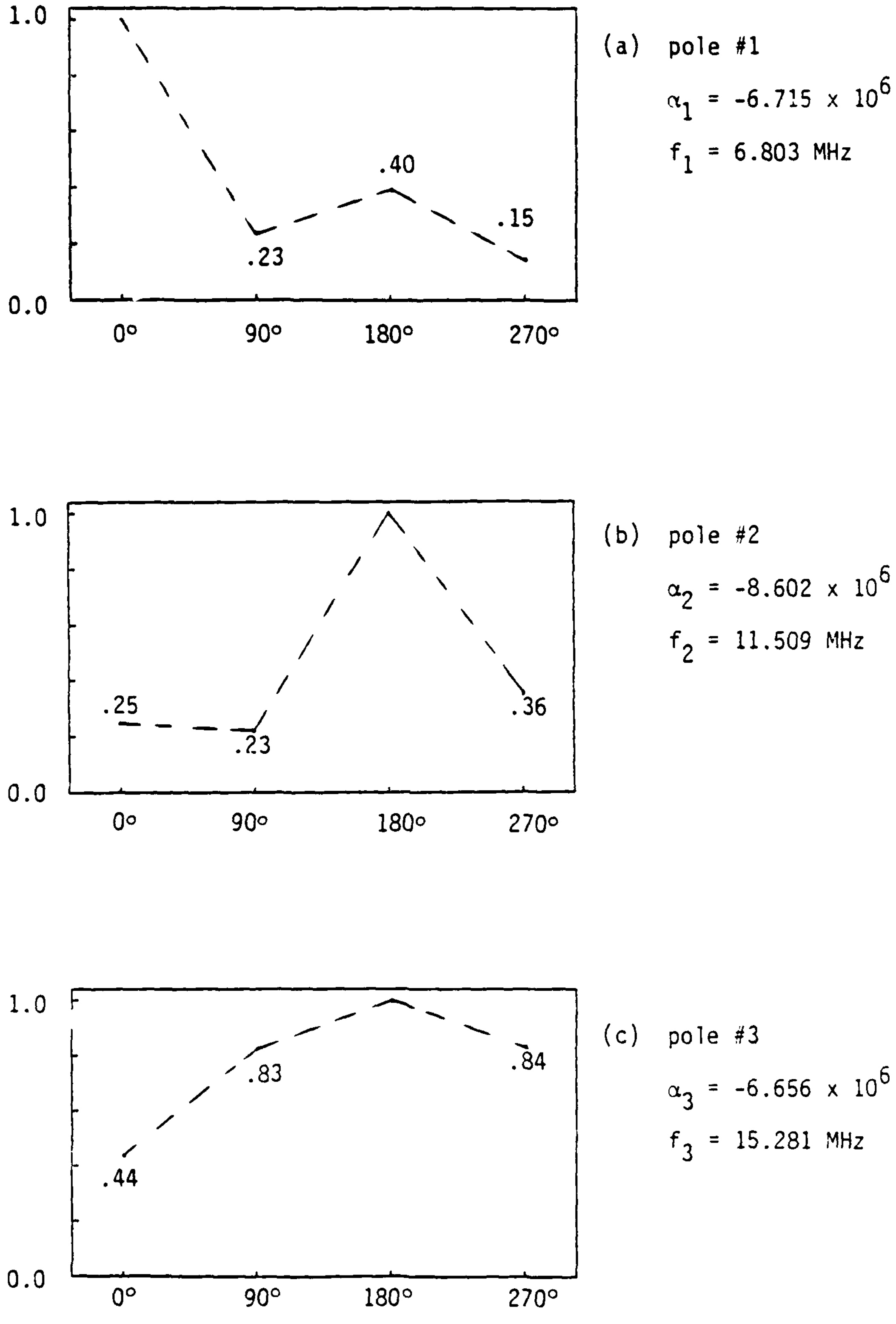


Figure 3. Amplitude of normalized coupling coefficients for the first 3 poles.

As shown in Chapter 4 (Ref. 2), the shorter the sampling rate, the smaller the percentage error in the pole estimate. Data sets with sampling rate of 5 ns should give better results.

The iterative preprocessing algorithm (IPA) (Ref. 2) was also used to find poles, but the results were almost identical.

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