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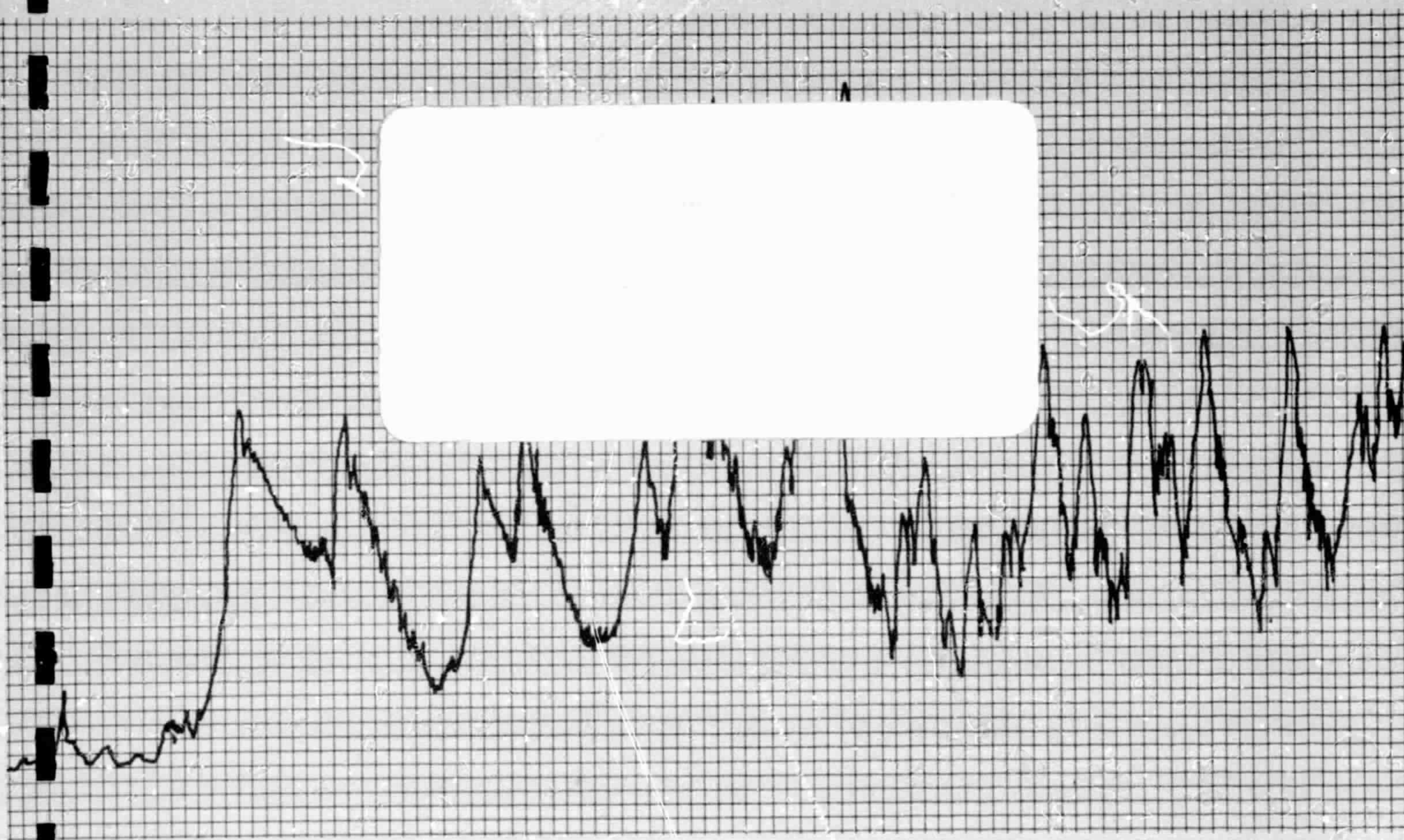

research REPORT

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EVALUATION OF SPACE SHUTTLE MAIN ENGINE FLUID DYNAMIC FREQUENCY RESPONSE CHARACTERISTICS

by

T. G. GARDNER

for

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
GEORGE C. MARSHALL SPACE FLIGHT CENTER
MARSHALL SPACE FLIGHT CENTER, ALABAMA 35812

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FOREWORD

This report was prepared by Wyle Laboratories, Research and Engineering Division, Huntsville, Alabama, under NASA Contract No. NAS8-33508, for the National Aeronautics and Space Administration (NASA), George C. Marshall Space Flight Center. The contract was administered under the technical direction of the Systems Dynamics Laboratory, with Mr. Harry Bandgren acting as the Technical Contracting Officer's Representative. Mr. Duron Cryder was the contract administrator for NASA.

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EVALUATION OF SPACE SHUTTLE MAIN ENGINE FLUID DYNAMIC FREQUENCY RESPONSE CHARACTERISTICS

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T. G. Gardner

ABSTRACT

In order to determine the POGO stability characteristics of the Space Shuttle main engine (SSME) liquid oxygen (LOX) system, an evaluation of the fluid dynamic frequency response functions between elements in the SSME LOX system was performed, both analytically and experimentally. This report acquaints the reader briefly with the POGO testing program and, more specifically, documents, as a user note, the POGO data analysis software. POGO refers to the effect the dynamic interaction between devices in the LOX system has on fluid/mechanical vibration of the system. For the experimental data evaluation, a software package was written for the Hewlett-Packard 5451C Fourier analyzer. The POGO analysis software consists of five separate segments. Each segment is stored on the 5451C disc as an individual program and performs its own unique function. The POGO analysis software includes two separate data reduction methods, a signal calibration, coherence or pulser signal based frequency response function blanking, and automatic plotting features. The 5451C allows variable parameter transfer from program to program. This feature is used to an advantage and requires only minimal user interface during the data reduction process. Experimental results are also included. Comparison of experimental results with the analytical predictions permits adjustments to the general model in order to arrive at a realistic simulation of the POGO characteristics.

SPACE SHUTTLE MAIN ENGINE SYSTEM DESCRIPTION

The Space Shuttle propulsion system consists of two solid rocket boosters (SRBs) and three main engines (SSMEs). The SSMEs are high-performance, liquid-propellant, variable thrust rocket engines, operating at high temperatures, high pressures, and high rotational speeds. Each SSME operates at a chamber pressure of approximately 3000 psia to produce a sea level thrust of 375,000 pounds and vacuum thrust of 470,000 pounds and operates over a range from 50 to 109 percent of the rated power. Each engine consists of ten major components: two preburners, four turbopumps, the hot-gas manifold, the main injector, a heat exchanger, and the main combustion chamber. All other components are attached structurally to the hot-gas manifold, and the entire arrangement is called the SSME powerhead.

A key to the cost effectiveness of the Space Shuttle concept is hardware reusability. As a result, system reliability is of paramount importance. The SSMEs have been subjected to extensive hot firing and flow tests. Under these extreme operating conditions, system failures and malfunctions have occurred due to the self-induced dynamic environment. These failures have ranged from subcritical wear of component bearings to catastrophic explosion and fire resulting from the intense pressure oscillations and dynamic stresses occurring in pumps, valves, and/or propellent lines. The components in the liquid oxygen (LOX) system include the low pressure oxidizer pump (LPOP), POGO suppression system (or accumulator), the high pressure oxidizer pump (HPOP), and the main combustion chamber (MCC). The LOX flows from the external tank (ET) through the above components and is combined with the liquid hydrogen (LH_2) fuel at the inlet of the MCC by the main injector.

The LPOP is an axial-flow pump driven by a six-stage turbine and powered by the LOX. During engine startup and mainstage, the LPOP maintains sufficient pressure in the LOX line to permit the HPOP to operate at high speeds without an inducer and without cavitation, even under worst-case conditions.

The POGO suppressor is a gas-filled accumulator, which serves as a capacitance in the LOX flow circuit. The unit is designed to prevent low-frequency oscillations, transmitted from the Space Shuttle vehicle, from being transmitted into the HPOP and ultimately to prevent MCC pressure oscillations. To provide suppression protection through the startup and shutdown transients, the accumulator is filled with gaseous helium. During normal engine operation, the heat exchanger provides gaseous oxygen (GO_2), as the compliant medium, to the accumulator. The system consists of a 0.6 cubic-foot accumulator, which is attached to the HPOP inlet duct, an internal stand pipe, helium precharge valve package, gaseous oxygen supply valve package, and recirculation isolation valves. The liquid level in the accumulator is controlled by the stand pipe, which is orificed to regulate the GO_2 overflow over the engine operating power level range. Excess gaseous and liquid oxygen are recirculated back to the LPOP inlet through the engine oxidizer bleed duct.

The HPOP consists of two single-stage centrifugal pumps on a common shaft, which is directly driven by a two-stage hot-gas turbine. The main pump receives oxidizer from the LPOP discharge and supplies LOX at increased pressure to the LPOP turbine. The HPOP turbine is powered by hot-gas (hydrogen-rich steam). LOX enters the HPOP main pump through the main pump housing and flows through an inlet with a 50-50 flow split into a double-entry, common outlet impeller. Several sets of guide vanes direct the flow to the impeller inlets. The impeller has four full and four partial blades in each half. After passing through the impeller, the flow is redirected into the HPOP discharge by diffuser vanes. The HPOP is attached to the hot-gas manifold by a flange, which is canted ten degrees out from the engine centerline. The oxidizer then flows into the MCC.

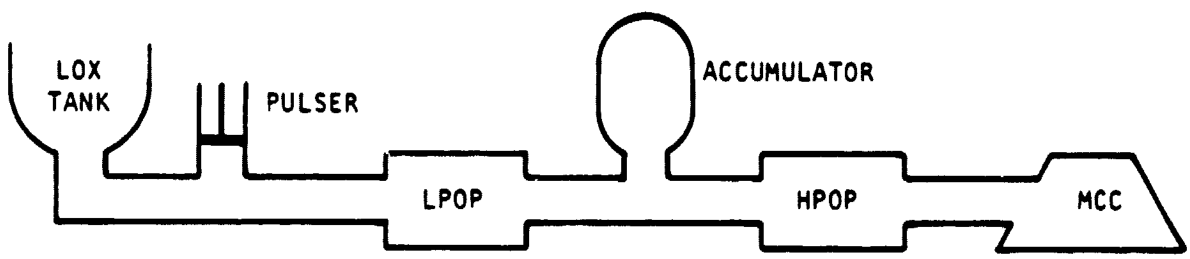
The MCC is a cylindrical structural chamber, which contains the burning propellant gases and is flange-attached to the hot-gas manifold. The MCC consists of a coolant liner, coolant inlet and outlet manifolds, and a structural jacket. The coolant liner, which provides the coolant flow path of the MCC, contains 390 milled axial coolant channels, which are ported to the coolant inlet and outlet manifolds. This network provides an up-pass circuit for the liquid hydrogen coolant. The chamber jacket provides the structural strength for the MCC and is approximately 20 inches long. The jacket is formed in two matching halves, which are welded together and to the coolant inlet and outlet manifolds. A throat ring is also welded to the jacket at the MCC throat to provide added strength. The MCC throat follows a contraction from the hot-gas manifold of 2.96:1 and is expanded to a ratio of 5:1 before attaching to the engine nozzle.

In order to validate system performance and ensure equipment reliability, the SSME and components have been and are presently undergoing extensive development and qualification tests. Testing of the engine and components is conducted at several NASA and contractor locations. Full-scale engine test firings for development and flight acceptance are performed on two single-engine test stands at the National Space Technology Laboratories (NSTL), Bay St. Louis, Mississippi, and one stand operated by Rockwell International near Santa Susana, California. In addition, main propulsion testing is performed at NSTL on a stand designed to accommodate the Shuttle main propulsion system element--the three-engine cluster, external tank, and orbiter systems.

Testing is being performed on a continuing basis. The length of a given test is dependent on specific test objectives and may run from several seconds to over 800 seconds. During each test, comprehensive measurements are acquired to monitor system performance, including vibration, dynamic pressure and strain at critical engine locations. Several of these latter measurements are utilized on-line as emergency cutoff indicators, and all are recorded on magnetic tape for subsequent analysis and evaluation.

SPACE SHUTTLE MAIN ENGINE POGO TEST PROGRAM

As part of a program to determine the POGO stability characteristics of the Space Shuttle Main Engine (SSME) liquid oxygen (LOX) system, POGO tests were conducted by Rocketdyne engineers, in California, on the A3 SSME test stand. In order to define the system fluid dynamic characteristics, frequency response functions [H(f)] between various components are calculated from pressure measurements taken at various locations in the system. To calculate the H(f)s, a known pressure signal must be applied to the system and the system response to this signal measured. A pulser was used to generate this dynamic pressure signal, with the tests usually including both sine sweeps and sine dwells. The first device located downstream of the pulser is the low pressure oxidizer pump (LPOP), followed by the accumulator (or suppressor), the high pressure oxidizer pump (HPOP), and the main combustion chamber (MCC). With the accumulator active in the system, the pulser signal is suppressed such that it does not reach the MCC with sufficient strength to be measured adequately. Consequently, tests were conducted with the accumulator active and inactive. The general system diagram below shows the relative location of these devices. Pressure measurements were made at the pulser, the LPOP inlet, the HPOP inlet, and the HPOP discharge.



The pulser sine sweeps ranged in frequency from 2 to 40 Hz. At the higher frequencies in the pulser sweep, the displacement of the pulser piston and the corresponding amplitude of the pressure pulse generated were very small. The amplitudes of the pressure signals further down the line were essentially buried in the noise level and very difficult

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to measure. For the sine dwells, the magnitude of the pulsed signal can be increased, providing greater dynamic range in the data. The problems associated with the dwell testing are the increased time required to conduct the test and the fact that the frequency response functions can be defined only at the frequencies where the dwells are located. Because of this, a routine that will blank out invalid data in frequency response functions was included in the POGO analysis software. This blanking can be based on either the pulser signal or the coherence function, leaving only the frequency response function data at the frequencies where the pulser was operated. In the initial tests, the dwell frequencies were chosen at approximately 5-Hz intervals. In subsequent tests, the dwells were chosen closer together in order to better define the system frequency response.

POGO DATA ANALYSIS SOFTWARE

For organizational purposes and because of total size, the POGO data analysis software is divided into five segments. Each segment is stored separately on the 5451C disc and runs on the 5451C as an individual program. The 5451C Fourier operating system allows nesting of as many as ten programs. This is the feature that allows these five programs to operate together and perform the total POGO data analysis. The software includes two frequency response function [H(f)] calculation routines. These two data reduction methods are referred to as the RATIO and DIRECT methods for calculating frequency response functions. In the RATIO technique, all H(f)s are initially referenced to the pulser. These H(f)s are then divided, with the resulting quotient being the H(f) across various combinations of devices. For example, the H(f) between devices 2 and 3 in the following schematic may be calculated as the RATIO of the H(f) between devices 1 and 3 and the H(f) between devices 1 and 2.

$$H(f)_{3/2} = \frac{H(f)_{3/1}}{H(f)_{2/1}} \ ,$$

where $H(f)_{n/l} = \frac{G_{nl}}{G_{11}}$ and n = output, l = input [1, 2]. Here G_{nl} is the cross spectrum between the input and output, and G_{11} is the autospectrum of the input (pulser).

> NOTE: The POGO software outputs the auto (power) spectra and cross (power) spectra as functions normalized to the bandwidth (Δf) or as power spectral densities (PSDs) and cross-power spectral densities (XPSDs). However, the 5451C calculates and uses the functions in their nonnormalized form to calculate frequency response functions [H(f)s] and coherence functions [γ^2(f)s] [2]. In the remainder of this document, all spectral functions will be referred to as PSDs and XPSDs regardless of their actual state of normalization. The reader should understand that all H(f) and γ^2(f) calculations are made prior to normalization.

To calculate the $\gamma^2(f)$ that is compatible with the RATIO H(f), the following formula is used [3]:

$$\gamma^2(f)_{3/2} = \frac{1}{\frac{1}{\gamma^2(f)_{3/1}} + \frac{1}{\gamma^2(f)_{2/1}} - 1}$$

where $\gamma^2(f)_{n/1} = \frac{|G_{n1}|^2}{G_{11}G_{nn}}$, and n and 1 are output and input, as above [1, 2].

To arrive at $H(f)_{3/2}$ and $\gamma^2(f)_{3/2}$ using the direct method involves calculating the frequency response function as the XPSD, between devices 3 and 2, and divided by the PSD of device 2. The coherence is calculated as the magnitude squared of the XPSD divided by both the input and output PSDs. These equations are as follows:

$$H(f)_{3/2} = \frac{G_{32}}{G_{22}}$$

$$\gamma^2(f)_{3/2} = \frac{|G_{32}|^2}{G_{22}\ G_{33}}$$

where G_{32} = XPSD, G_{22} = input PSD, and G_{33} = output PSD.

The POGO software also calculates frequency response functions, both RATIO and DIRECT, which have been blanked, based on either the coherence or the pulser signal. Blanking means that the frequency response function magnitude and phase are set to zero at those frequencies where the value of the coherence, or pulser signal, does not exceed the user set minimum.

As previously stated, the POGO analysis software consists of five segments, each of which is stored on the 5451C disc in a separate keyboard program file (KPF) record. They are currently stored in successive records (1 - 5) on the Marshall Space Flight Center, Systems Dynamics Lab's 5451C Fourier software disc.

KEYBOARD PROGRAM FILE, RECORD 1

KPF1 contains part 1 of three parts, which perform the RATIO calculations. Part 1 sets up the data block size, calibration factors, total amount of data to be taken, and delta f (Δf) [frequency resolution or bandwidth]. This information is used to calculate both the RATIO and DIRECT H(f)s. The 5451C has a block arithmetic mode, which allows any block of data to be multiplied or divided by any number. This number, however, must be an integer. If this number happens to be a floating-point variable parameter (VP), the 5451C simply truncates any part of the VP that lies to the right of the decimal. In reference to this problem, the POGO analysis software first multiplies each calibration factor by 100, then calibrates the appropriate data block, and finally divides the data block by 100. This allows for two decimal places in each calibration factor. The same type procedure is used with regard to the VP that holds the Δf parameter, to allow for one digit to the right of the decimal when calculating PSDs. After the initial setup, KPF1 reads the analog data from the tape and stores it on the ADC Throughput File, beginning at record 0. KPF1 then retrieves this time domain data, two channels at a time, and calculates PSDs for each channel. KPF1 also calculates H(f), γ^2(f), and XPSDs for the three pairs, LPOP/pulser, HPOP/pulser, and MCC/pulser. This data is stored in data blocks 12 through 27. Program control is then transferred to KPF2, which is part 2 of the POGO analysis software.

KEYBOARD PROGRAM FILE, RECORD 2

KPF2 begins the calculations for the RATIO H(f)s and γ^2(f)s. The 5451C has preprogrammed keys that will perform the arithmetic necessary to make these calculations. The keys, however, perform what will be referred to as block arithmetic. The 5451C stores data in blocks internally, in a format Hewlett-Packard calls floating-point-by-block. This means that the data block is actually a group of integers, all with a common scale factor. Because of this method of data handling, the arithmetic operation performed by the block command is not floating point, but is integer arithmetic. These operations involved in the

RATIO calculations are limited to a 40-dB dynamic range. When inverting a number, as that number approaches zero, the inverse approaches infinity. It becomes apparent that if there are any numbers whose value is less than 0.01 in a data block, any number greater than or equal to 1 will be more than 40 dB down when that block is inverted. The 5451C automatically scales up the block scale factor to eliminate overflowing, which causes any number more than 40 dB down to be set to zero. This is a serious problem when doing the type of calculation involved in arriving at the RATIO H(f)s and γ^2(f)s. In both of these calculations, especially the $\gamma^2(f)$ calculation, the quotient in the formulations is dominated by the small numbers in the denominator. These small numbers are not reliable data points, and the valid data is lost below the 40-dB dynamic range.

The problem was solved in this program by using a floating-point arithmetic scheme in the $\gamma^2(f)$ calculations and a combination of floating-point arithmetic and a filtering technique in the H(f) calculations. The floating-point scheme involves extracting each channel (or data point) point-by-point from a data block, putting the value into a floating-point format (via a floating-point variable parameter), executing the arithmetic operation, and finally putting the datum back into the data block. A magnitude filtering technique is used in the H(f) calculation to eliminate a loss of data after the values are put back into the data block. The real and imaginary parts of the H(f) are filtered so that any values outside the range of ± 7 are set to zero. This allows a polar magnitude maximum of 10. The 40-dB dynamic range then will be 10^{-1} to 10^{1}. This filtering technique is not necessary in the $\gamma^2(f)$ calculations because of the final quantity inversion in the formulation. All the values to be inverted, however, are scanned for values of identically zero before inversion. This is to eliminate any numbers actually going to the upper limit (infinity).

The program loops through the above operation enough times to calculate the RATIO H(f) and $\gamma^2(f)$ for each channel in the data block. This loop is nested inside a loop, which allows for all three sets of ratio calculations to be computed. Part 2 of the POGO analysis software then transfers control to part 3.

KEYBOARD PROGRAM FILE, RECORD 3

KPF3 defines the variable parameter, corresponding to the ratio calculations, necessary to operate the plot routine. KPF3 also performs the calculations involved in the H(f) blanking routine. KPF3 has several entry points, which allow various operations to be performed outside the normal program flow. KPF2 flows into the beginning of KPF3, which jumps to the blanking routine. The blanking routine begins by prompting the user to establish whether the blanking will be based upon the $\gamma^2(f)$ or the pulser PSD. The user will enter either a zero, to establish coherence blanking, or a two, to define pulser blanking. This number (0 or 2) will also be used to establish which labels will be given to the plots of the blanked H(f)s during the plot routine. If pulser blanking is chosen, KPF3 will display the pulser PSD to allow the user an opportunity to view the signal and decide on the minimum value used for the blanking routine. If $\gamma^2(f)$ blanking is chosen, KPF3 skips directly to the next step, which is a prompt, asking for the minimum value in the blanking routine. Next, KPF3 sets up the block that will be used for generating the blanked H(f). KPF3 then enters the blanking loop. This loop operates individually on each channel in the frequency domain data block. In this loop, KPF3 goes to either the pulser or $\gamma^2(f)$ block and gets one channel at a time, beginning with channel one (channel zero is the first channel) and ending with the next to last channel in the data block. The value of this channel is compared with the values of the channel immediately preceding and the channel immediately following. If the value of the channel in question is greatest, it is determined to be a local maximum. The value is then compared with the minimum value specified earlier by the user. If the value of this channel is greater in all three tests, it is chosen as a channel of interest. The corresponding channel in the H(f) data block is gathered into a complex variable parameter and stored in the data block that was prepared previously for the blanked H(f). When the loop is complete, the blanked H(f) will consist of calculated H(f) data only at those frequencies where the pulser or $\gamma^2(f)$ passed all the necessary tests. The remainder of the blanked H(f) block will be filled with zeros. Because the HP 5451C stores frequency domain data with both real and imaginary information in a combined complex channel, the blanked H(f) contains blanked phase information as well as blanked magnitude. KPF3 then loops three times to generate a blanked version of each H(f), HPOP/LPOP, MCC/HPOP, and MCC/LPOP. KPF3 then jumps to the section that defines the variable parameters necessary to run the plot program. Finally, KPF3 transfers control to KPF5, the POGO plot routine.

KEYBOARD PROGRAM FILE, RECORD 4

KPF4 is a single-part program, which calculates the H(f)s, HPOP/LPOP, MCC/HPOP, and MCC/LPOP by matching the outputs and inputs "directly" rather than ratioing H(f)s, which have all been referenced to the pulser. This program (KPF4) uses several variable parameters, which must have been previously defined by running the first three files containing the RATIO software. These variable parameters are VP1 = block size; VP2 = number of ADC Throughput records; VP2000 through VP2003 = calibration factors for channels A through D, respectively; VP2004 = frequency resolution (Δf); and VP2030 = minimum value for the blanking routine. KPF4 also retrieves time domain data from the ADC Throughput File. These data must have been written previously on the disc (starting with record zero) via KPF1 (RATIO software, part 1). The data may be written to the disc and the necessary variable parameters defined independently of the RATIO software. It is recommended, however, that all programs be operated in sequence. The direct POGO analysis software (KPF4) writes over the data blocks generated via the RATIO software. This program therefore should not be initiated until all the required ratio data blocks have been reproduced. These data blocks include all PSDs and XPSDs (ref. pulser), which are not recalculated by the DIRECT software. Immediately after clearing the data blocks, KPF4 begins a loop that operates three times. The loop reads the correct data channels from the disc, Fourier transforms the data, calibrates the data, and calculates averaged PSDs via the special subroutine of the 5451C. KPF4 then calculates the H(f) and $\gamma^2(f)$ from the averaged PSD data. The H(f), γ^2(f), and XPSDs are then stored in the appropriate data blocks. (See "DIRECT POGO Program Menu," appendix C.)

KPF4 now transfers control to KPF3 at the point where the H(f) blanking loop begins. Before jumping to KPF3, KPF4 defines the variable parameters that describe the location of the DIRECT H(F)s. Once in KPF3 the blanked H(f)s are calculated using the same minimum value specified by the user during the RATIO calculations. If the user has entered the POGO software in the DIRECT calculations and wishes to change the minimum blanking value, the user simply jumps to label 43 of KPF4.

Upon returning from the blanking routine, KPF4 defines the variable parameters necessary to operate the POGO plot program (KPF5). KPF4 then transfers control to the plot routine.

KEYBOARD PROGRAM FILE, RECORD 5

KPF5 is entitled "POGO Plot Software." This software operates with both the RATIO and the DIRECT software. KPF5 uses several variable parameters that must be defined by the respective software whose data is to be plotted. The program is organized into several separate routines, including a plot routine, a hard copy routine, a delay routine, and a routine that sets up and plots all the H(f)s in three different formats. The program sets up and automatically plots all the data generated by the respective RATIO and DIRECT programs. The KPF5 prints a data block menu and allows the user to replot any of the data blocks. The plot program is geared to run with a Tektronics 4052 graphics terminal and a Tektronics hard copy unit. Because of various incompatibilities between the 5451C and the Tektronics terminal with respect to the time required to transmit plot commands and the time required to execute them, a delay routine is incorporated in the plot program. This subroutine simply counts from one to 50 and returns. The routine is called in several locations where a time delay between plot commands is necessary.

The plot program uses several variable parameters that establish which program (RATIO or DIRECT) has generated the data being plotted. The plot program also labels each plot with test ID information in the upper right-hand corner of the plot. This information is stored as message number one in each of the text buffers one and two. Text buffer #1 is used for the RATIO data, while text buffer #2 is used with the DIRECT data. Message #1 should be changed for each new set of test data. The message may be changed by executing the following set of operations from the 5451C terminal:

Step #	Command	5451C Status
1	Y 5403 (n1)	busy

This command calls text buffer n1 (1 for RATIO, 2 for DIRECT) into the computer core and activates the editing commands.

2	/R01	busy

This command tells the 5451C to replace message #1.

3	01	busy
4	(Test ID)	busy
5	/*	busy

This sequence of commands results in the test ID being recognized as message 01. The /* defines the end of the message.

6	/	busy

This command terminates the text buffer edit mode.

To allow the user to enter the program flow for special purposes, the POGO software has many labels throughout the five KPFs. Listed below are the various jump commands and their uses.

J 0 1

This command starts the POGO software, initially setting up the calibration factors, etc, and reading the analog data.

J 10 1

This command enters POGO Software Part 1 after all the initial values have been entered and the analog data has been stored on disc in the ADC Throughput File. If this command is to be executed, the user must first be sure that the variable parameters that contain the values for the blocksize, calibration factors, number of records of data, and frequency resolution (Δf) are defined correctly and that the correct time domain data is stored on the ADC Throughput File.

J 20 2

This command begins the RATIO calculations for H(f)s and γ^2(f)s. This command may be executed if the proper data blocks reside in core in the correct block numbers. The data blocks necessary are

H(f)	LPOP/Pulser	Block 12
γ^2(f)	"	Block 13
H(f)	HPOP/Pulser	Block 14
γ^2(f)	"	Block 15
H(f)	MCC/Pulser	Block 16
γ^2(f)	"	Block 17

H 30 3

This command may be used when the user wishes to recalculate the blanked RATIO frequency response functions. The user will have the opportunity to re-establish the type of blanking [pulser or γ^2(f)] and/or the minimum value for that blanking. The RATIO autoplot parameters are defined and the program control is transferred to the plot routine.

J 31 3

This command is preliminary to the POGO Plot Routine. This command enters KPF3 and defines the variable parameters necessary to run the automatic plot portion of the plot routine. After these parameters are defined, program control is automatically transferred to the plot routine. This command should be used only when the user wishes to enter the autoplot routine with RATIO data blocks. This command might be useful if, for example, the user wants to change the test ID message in the RATIO text buffer after the POGO software has completed the data calculations. The user can stop program execution and edit the text buffer, then return to the autoplot sequence.

J 40 4

This command begins the DIRECT POGO Software. This should be used only after the RATIO program has been run, defining the appropriate variable parameters, and writing the time domain data on the ADC Throughput File.

J 43 4

This command enters KPF4 where necessary variable parameters are defined just prior to transferring control to the H(f) blanking routine in KPF3. This command will allow the user to calculate DIRECT blanked H(f)s.

J 44 4

This command causes the computer to begin execution in KPF4 at the point where the variable parameters that control the autoplot routine for DIRECT data blocks are defined. Program control is automatically transferred to the plot routine.

J 53 5

This command will cause the plot program to display on the terminal the appropriate menu corresponding to the data stored in the data blocks. The plot program prompts the user to set the display scale as desired, then press the continue button to allow the program to plot the data block on the graphics terminal. This command is useful when the user wishes to return to the plot program after the machine has been idled and the plot routine pointers have been changed.

Appendix A describes the flow of the POGO software. Appendix B contains a complete list of all the program steps along with a description of each. Appendix C contains a listing of the text record messages used with the POGO software. Appendix D contains a listing of both text buffers used with the POGO software. Appendix E contains sample data output from the POGO software.

REFERENCES

1. Bendat, J. S., and A. G. Piersol. *Random Data: Analysis and Measurement Procedures*. John Wiley & Sons, New York, 1971.
2. Schiesser, W. E. Statistical Uncertainty of Frequency Response Determined from Random Signals. Weston-Boonshaft and Fuchs, NASA Bulletin 711-C2.
3. Hewlett-Packard. 5451C Fourier Analyzer System Manual (Binder No. 1). Mar. 1979.

APPENDIX A

POGO SOFTWARE FLOWCHART

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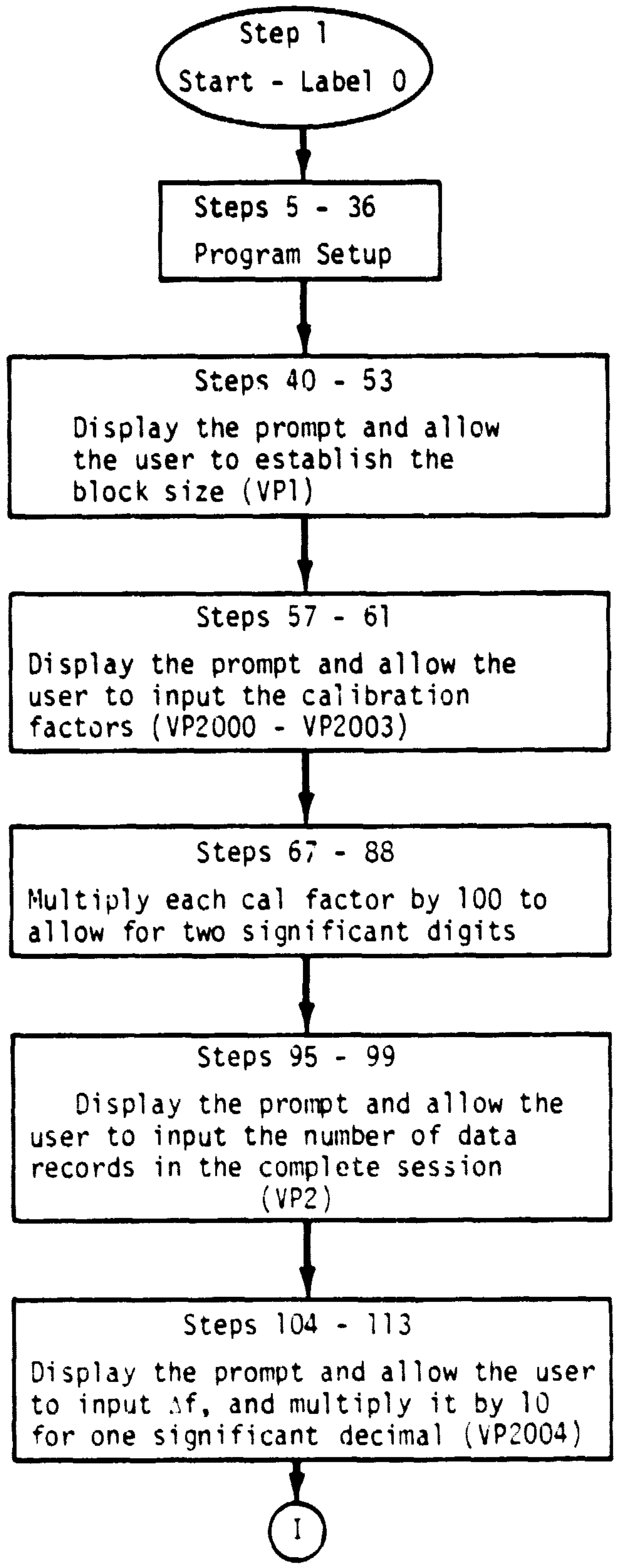
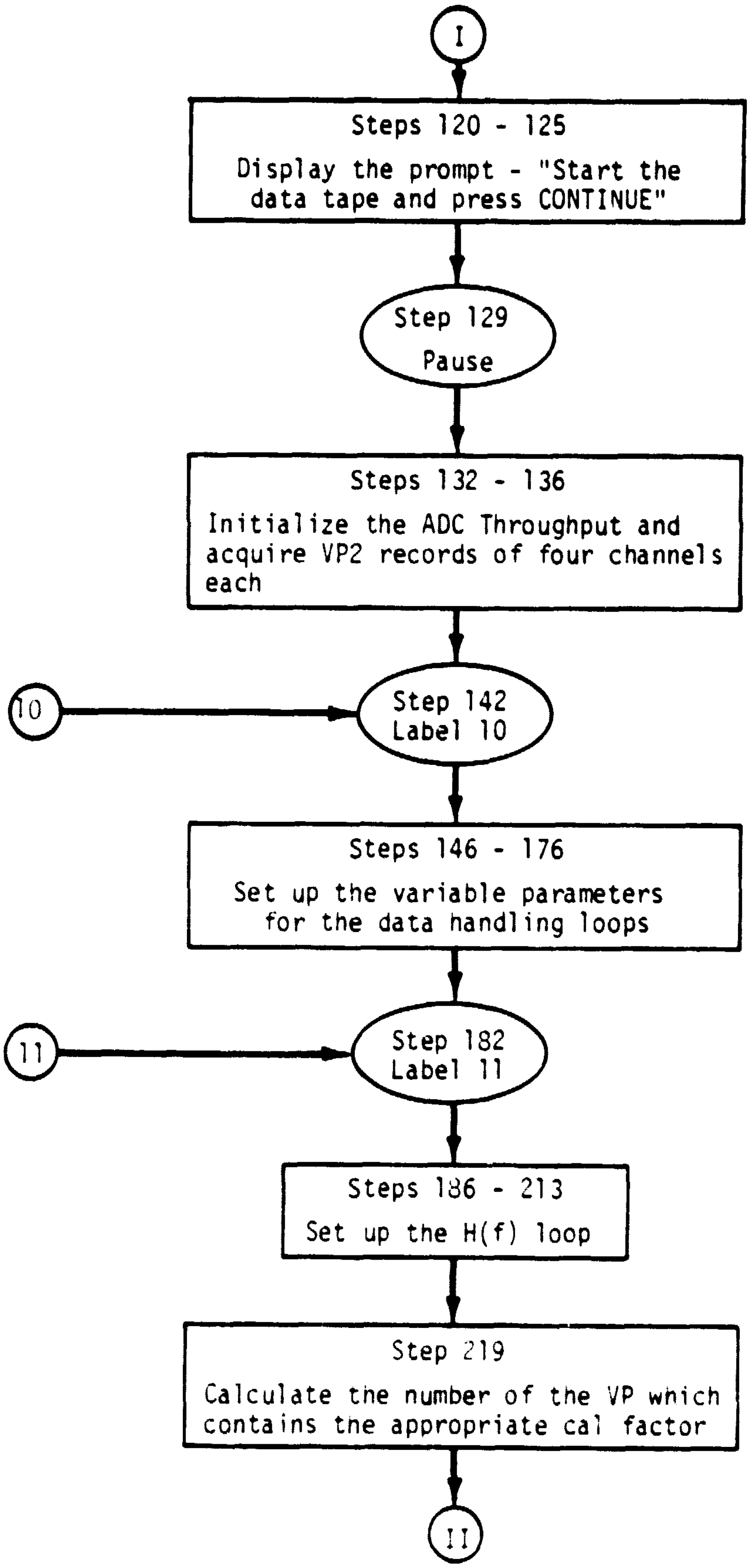
POGO SOFTWARE FLOWCHART

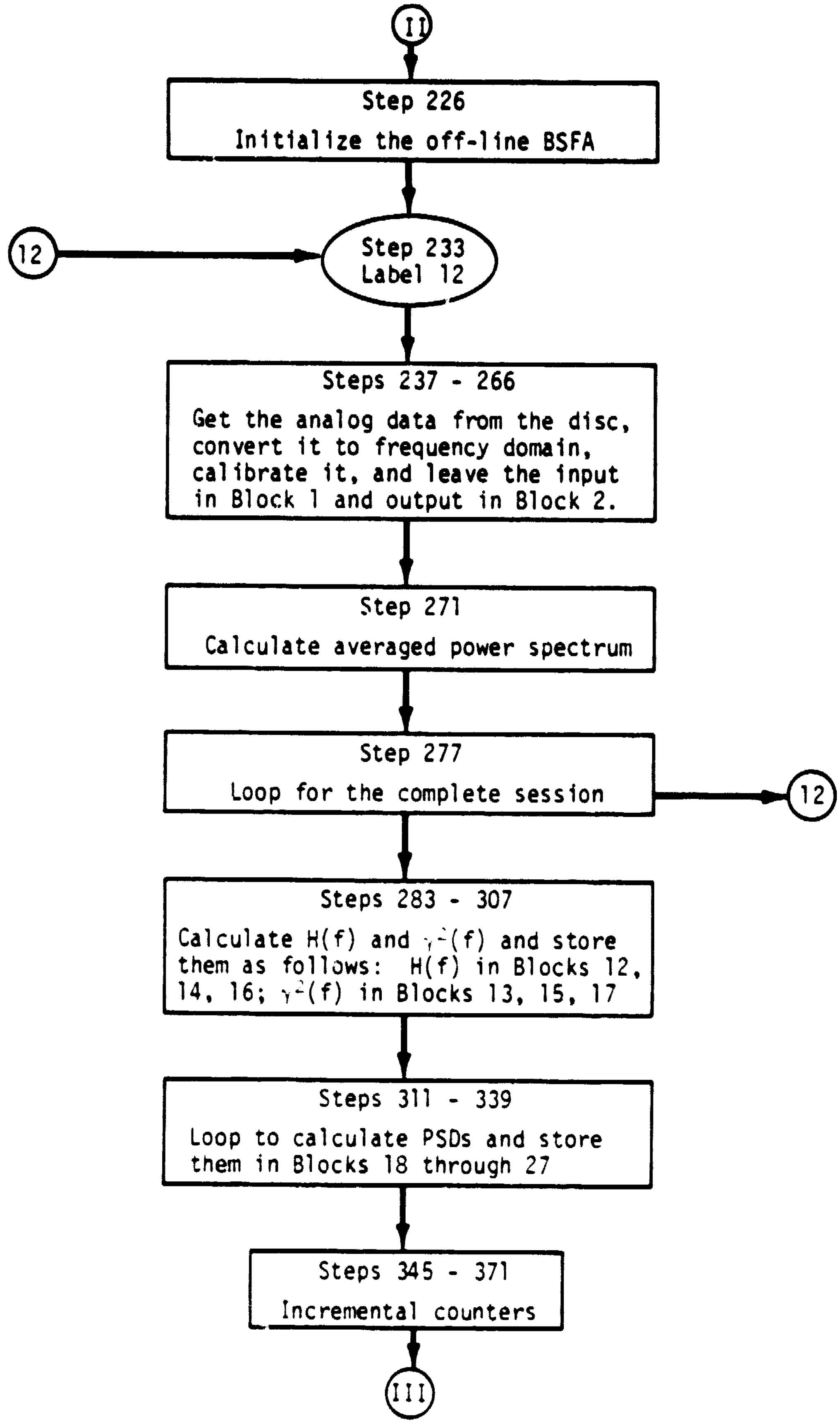
RATIO POGO SOFTWARE - PART 1 FLOWCHART



RATIO POGO SOFTWARE - PART 1 FLOWCHART (Continued)



RATIO POGO SOFTWARE - PART 1 FLOWCHART (Continued)



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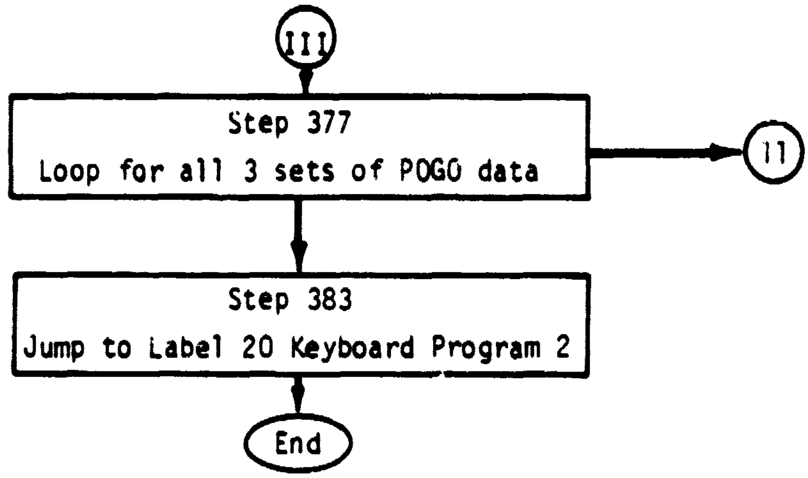
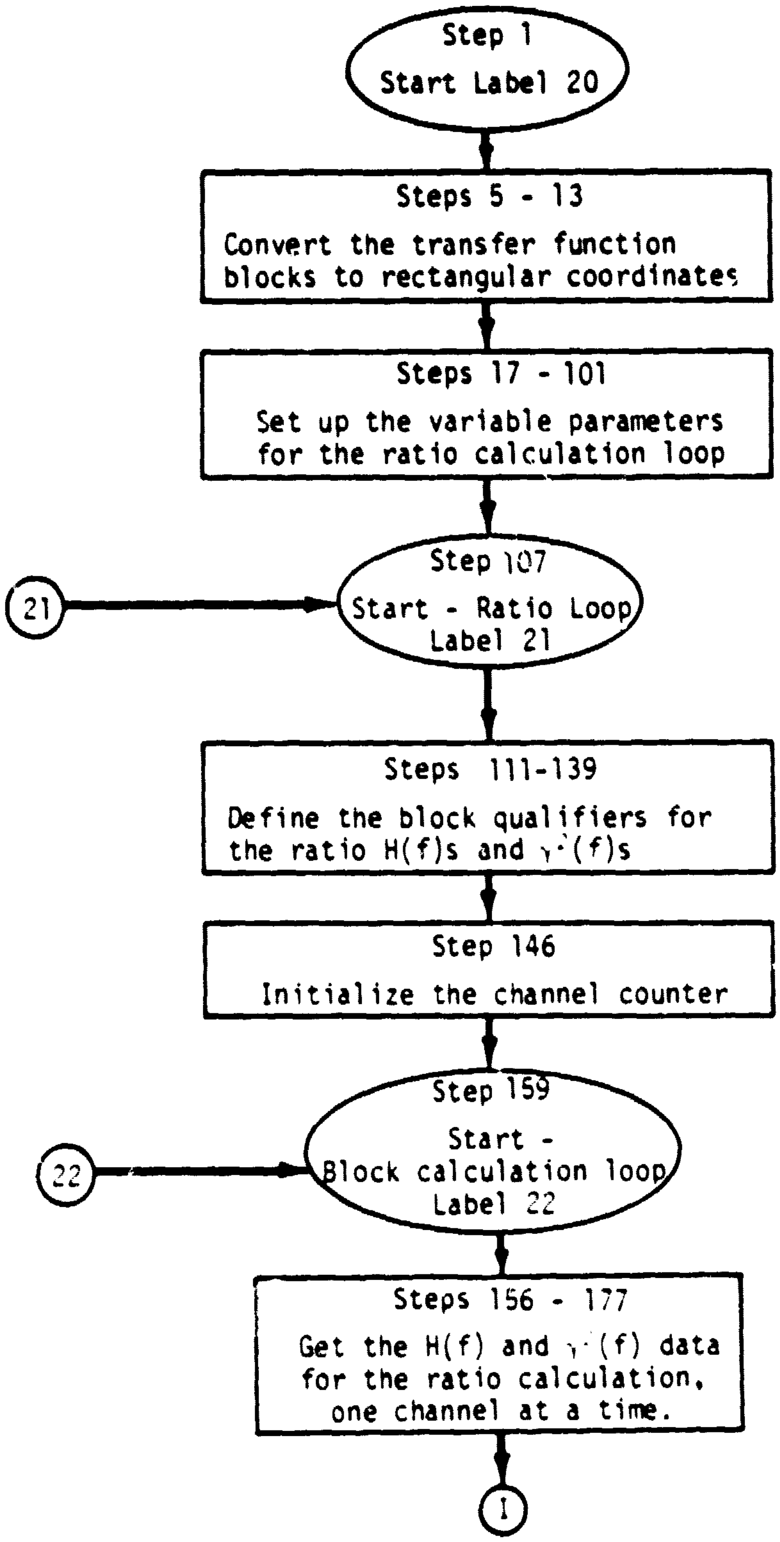
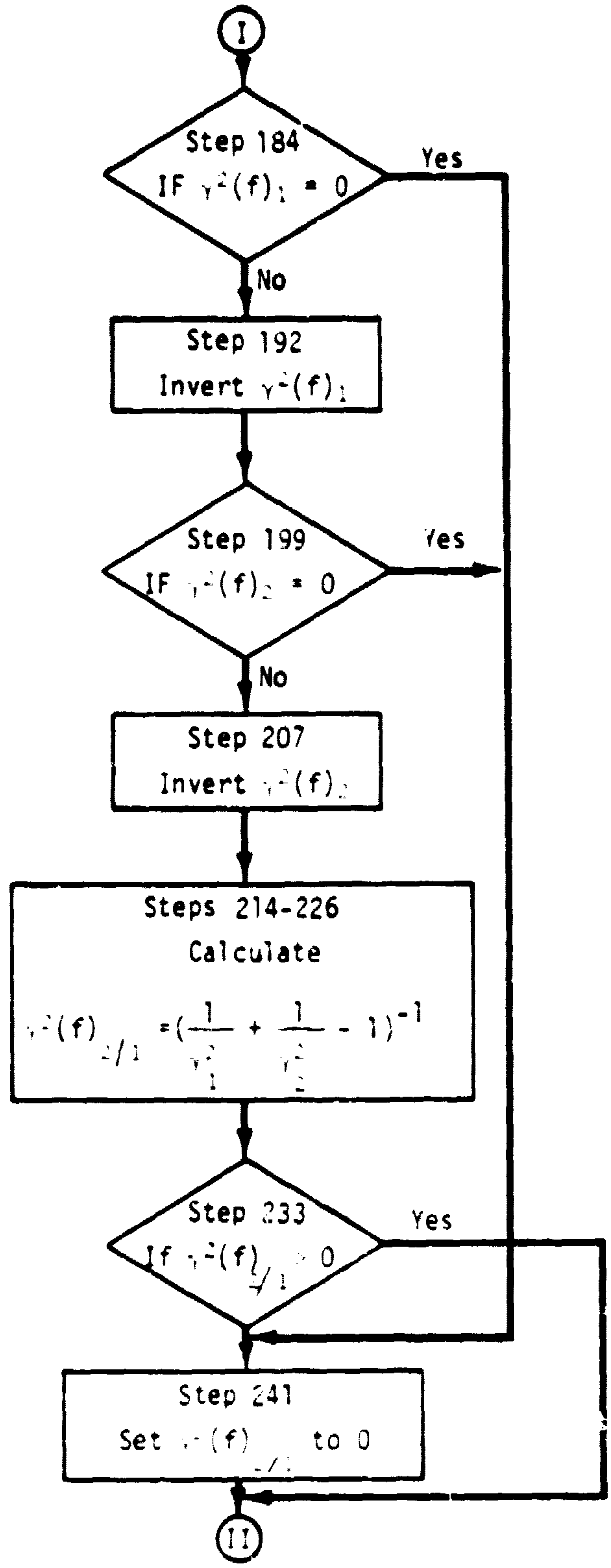


RATIO POGO SOFTWARE - PART 2 FLOWCHART

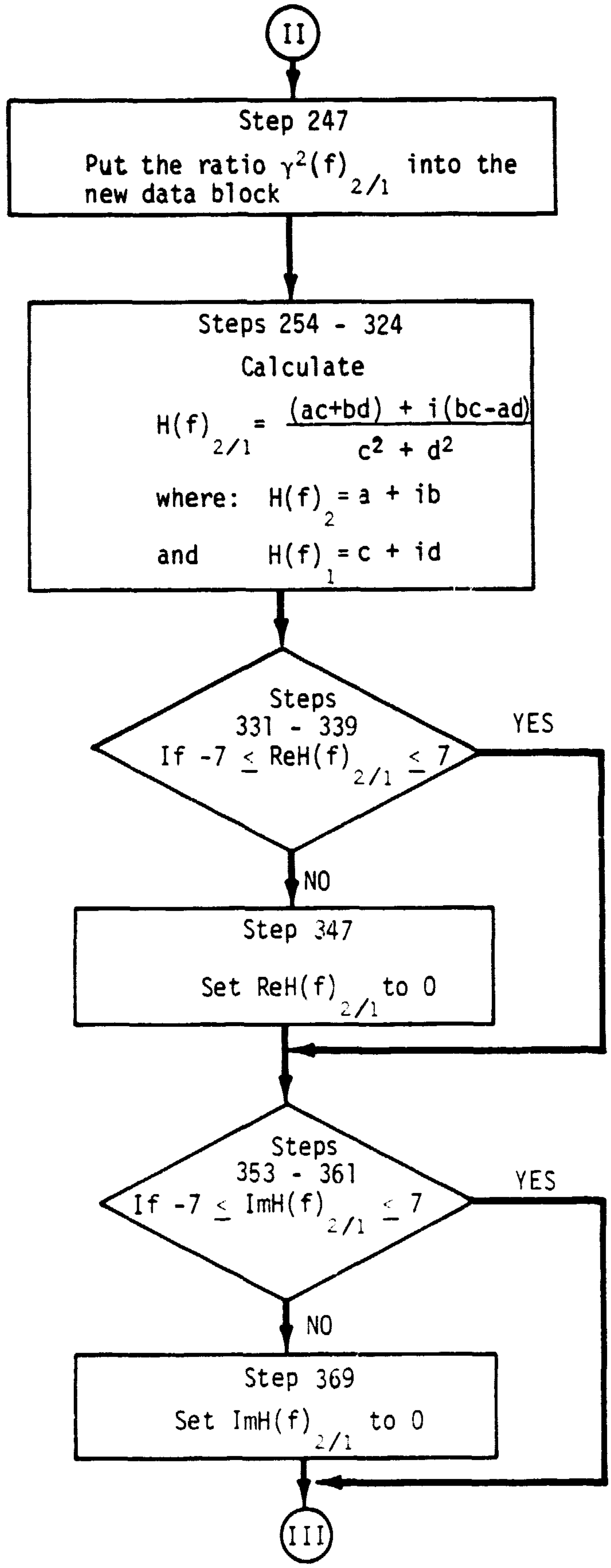


A6

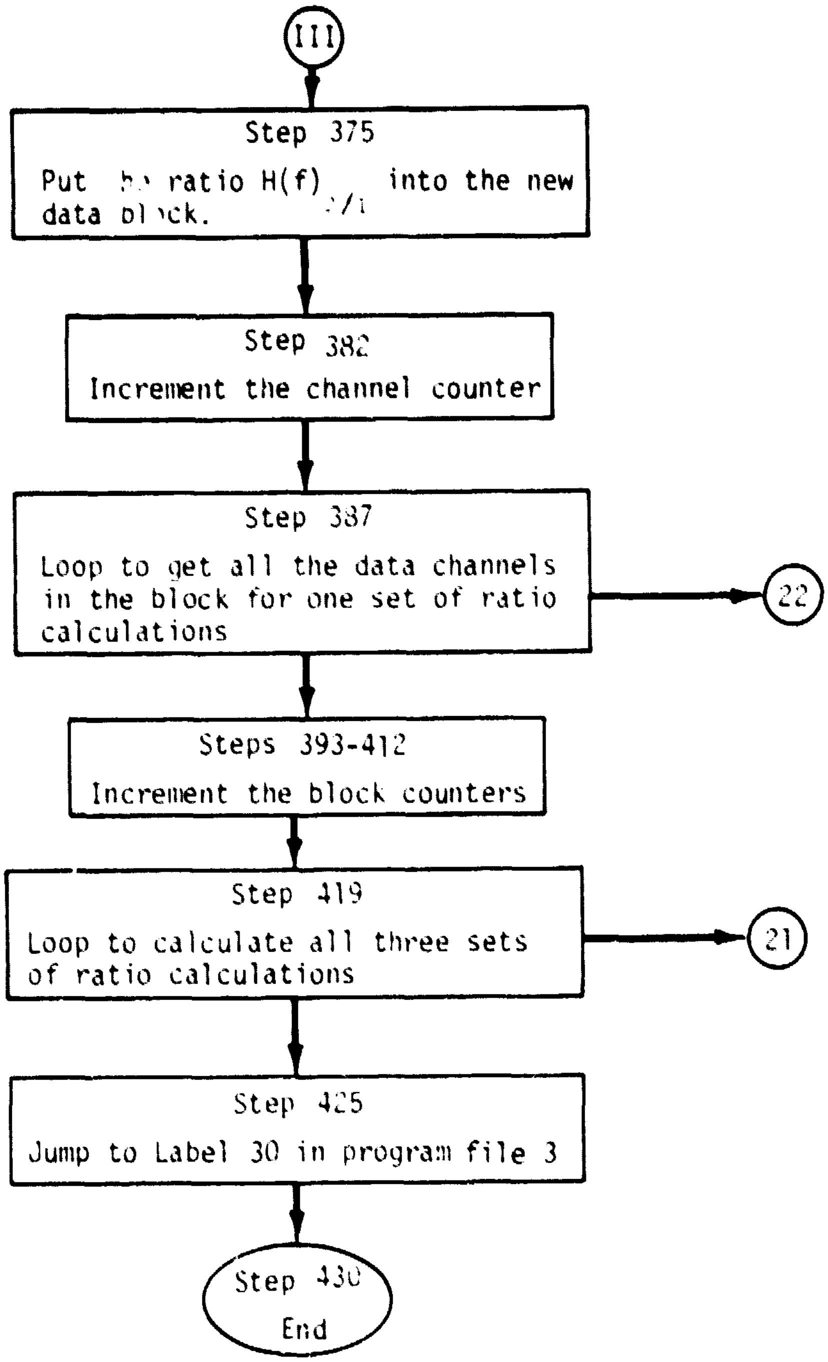
RATIO POGO SOFTWARE - PART 2 FLOWCHART (Continued)



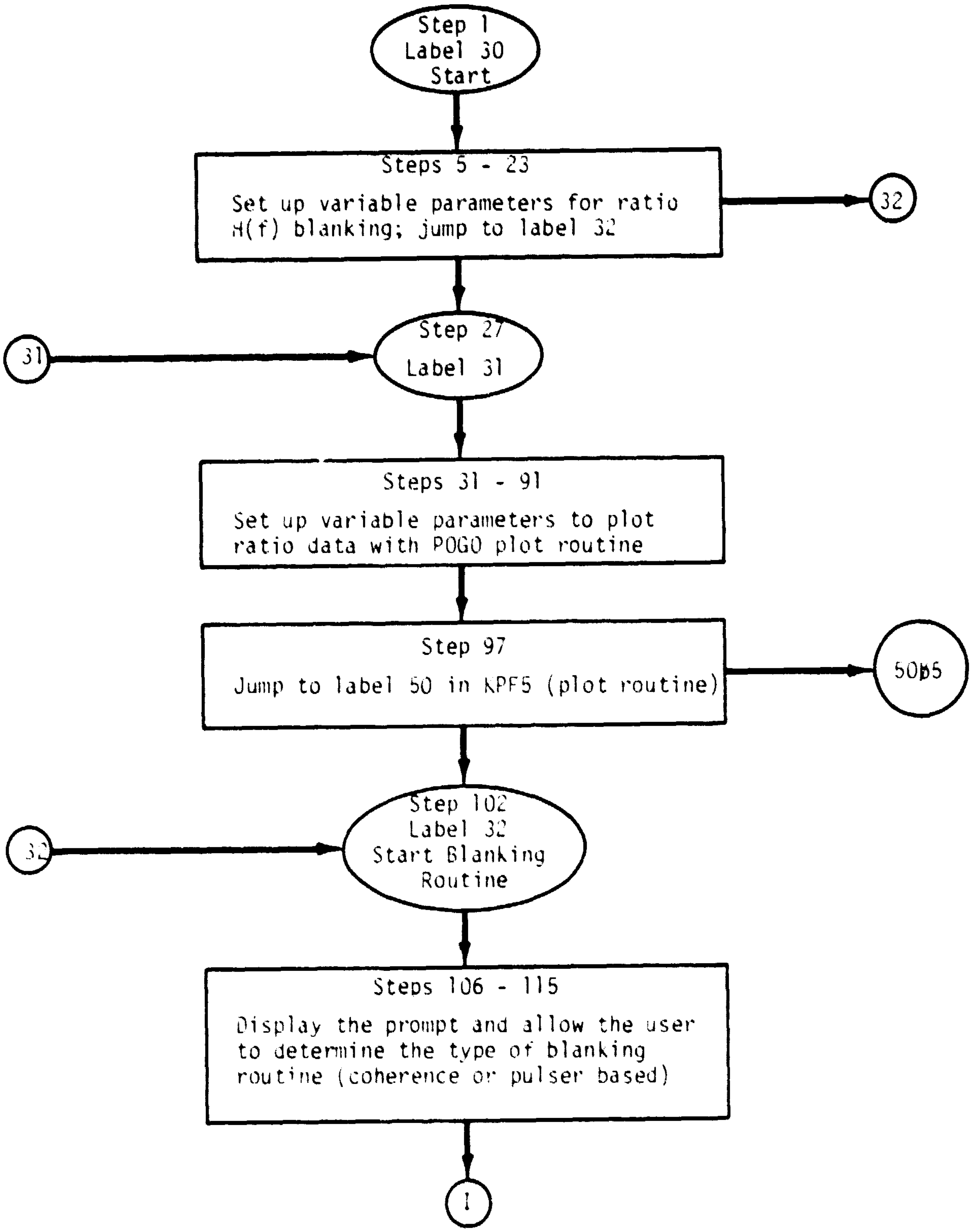
RATIO POGO SOFTWARE - PART 2 FLOWCHART (Continued)



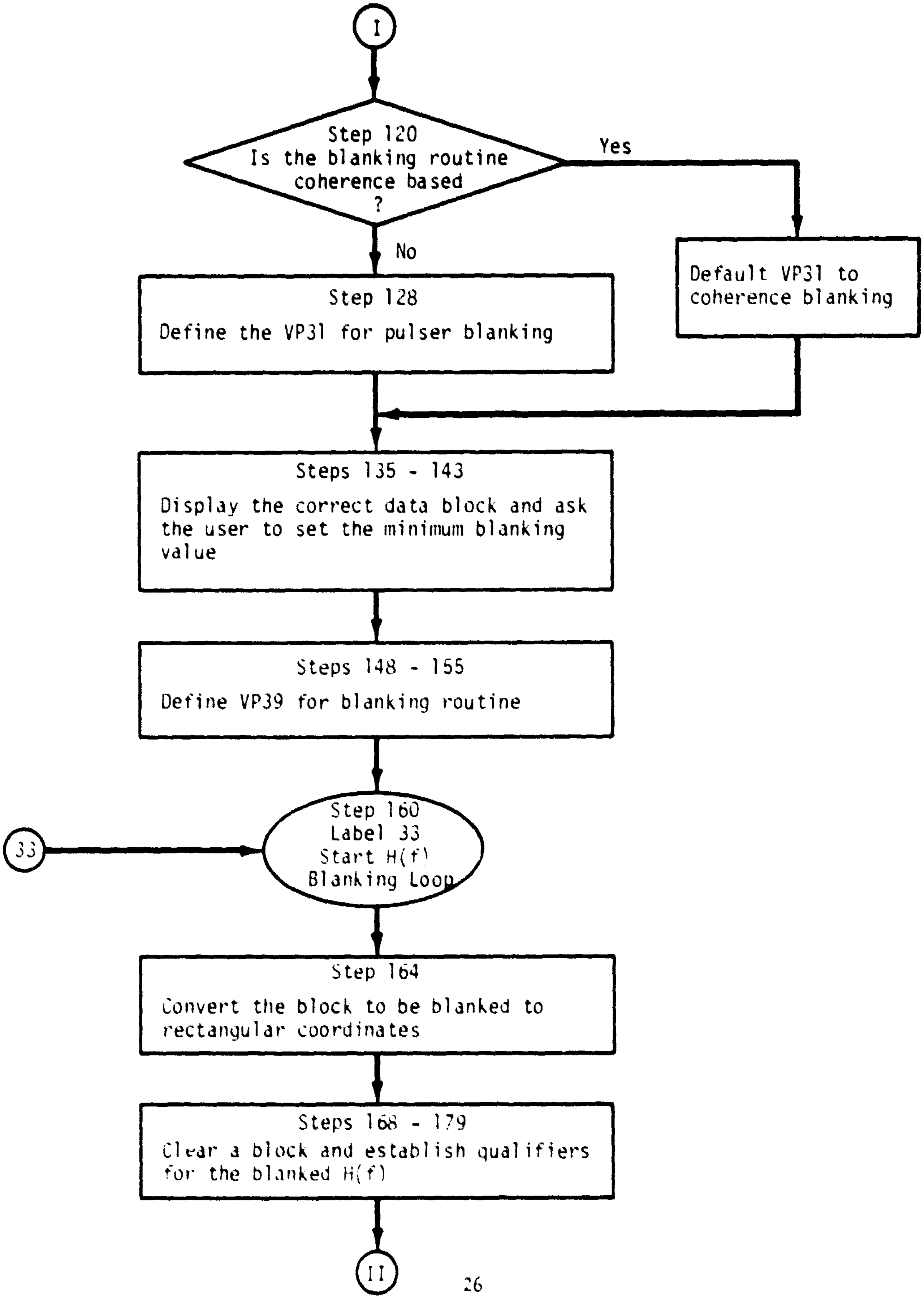
RATIO POGO SOFTWARE - PART 2 FLOWCHART (Concluded)



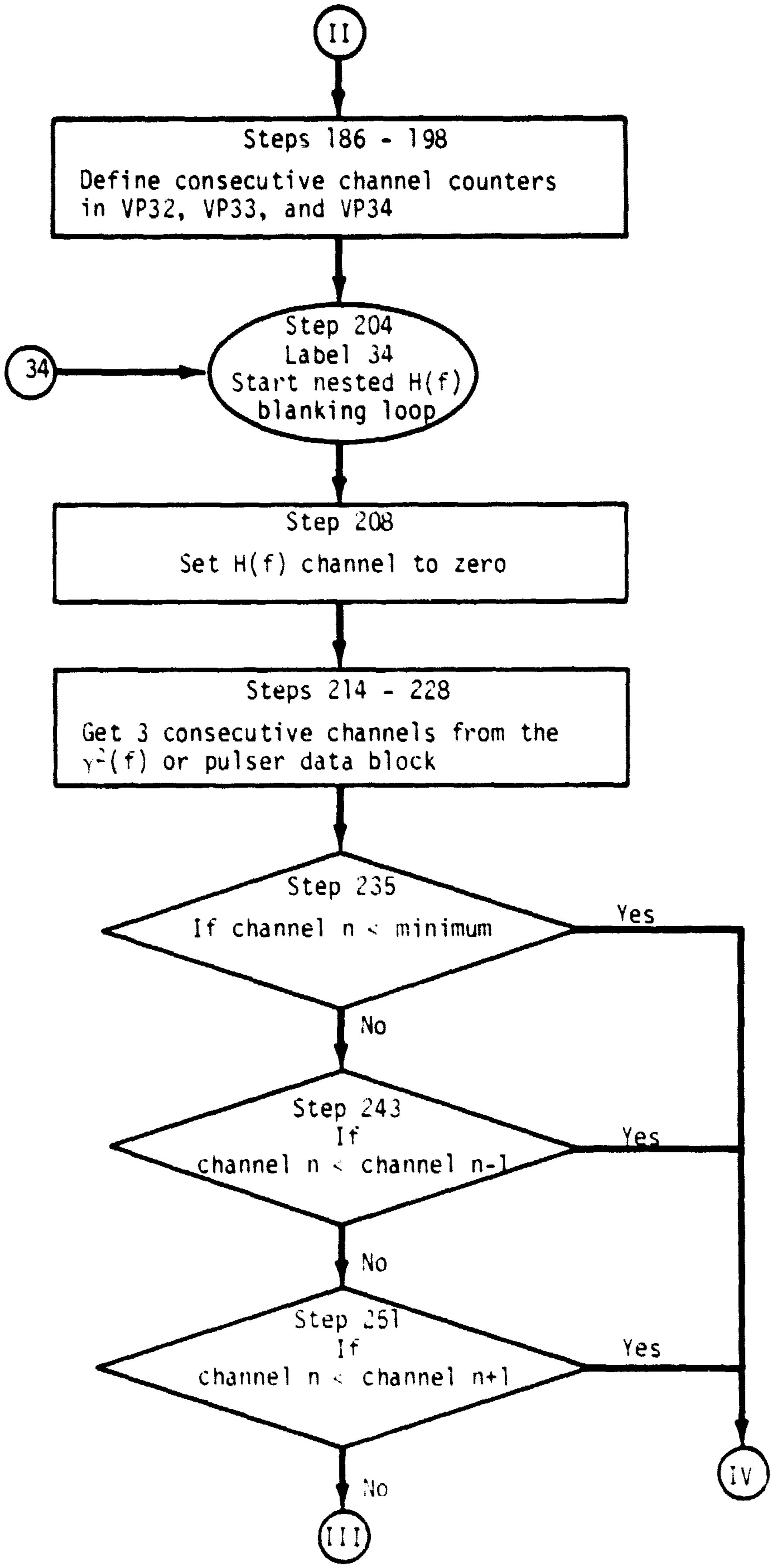
POGO SOFTWARE BLANKING ROUTINE



POGO SOFTWARE BLANKING ROUTINE (Continued)

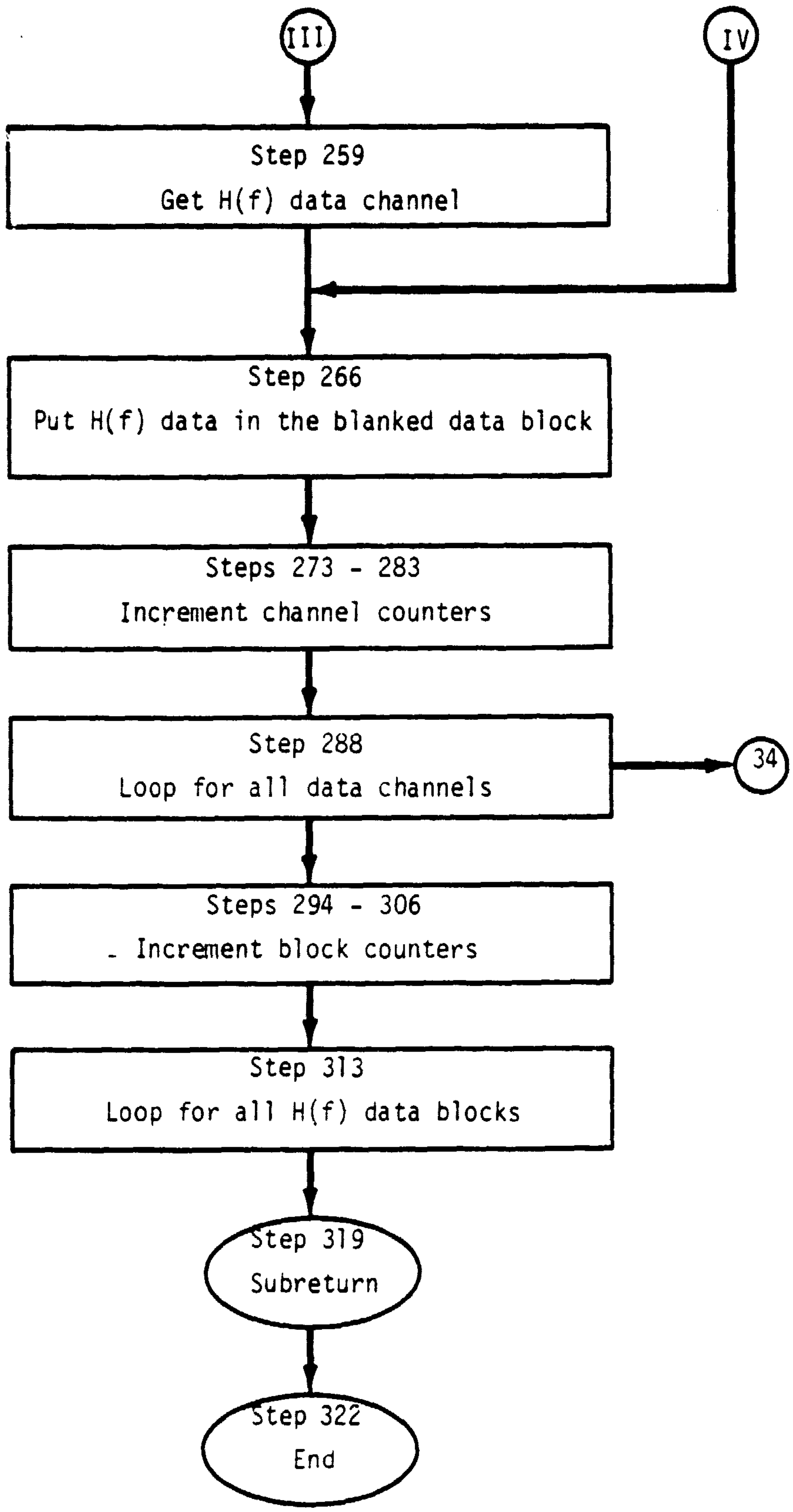


POGO SOFTWARE BLANKING ROUTINE (Continued)

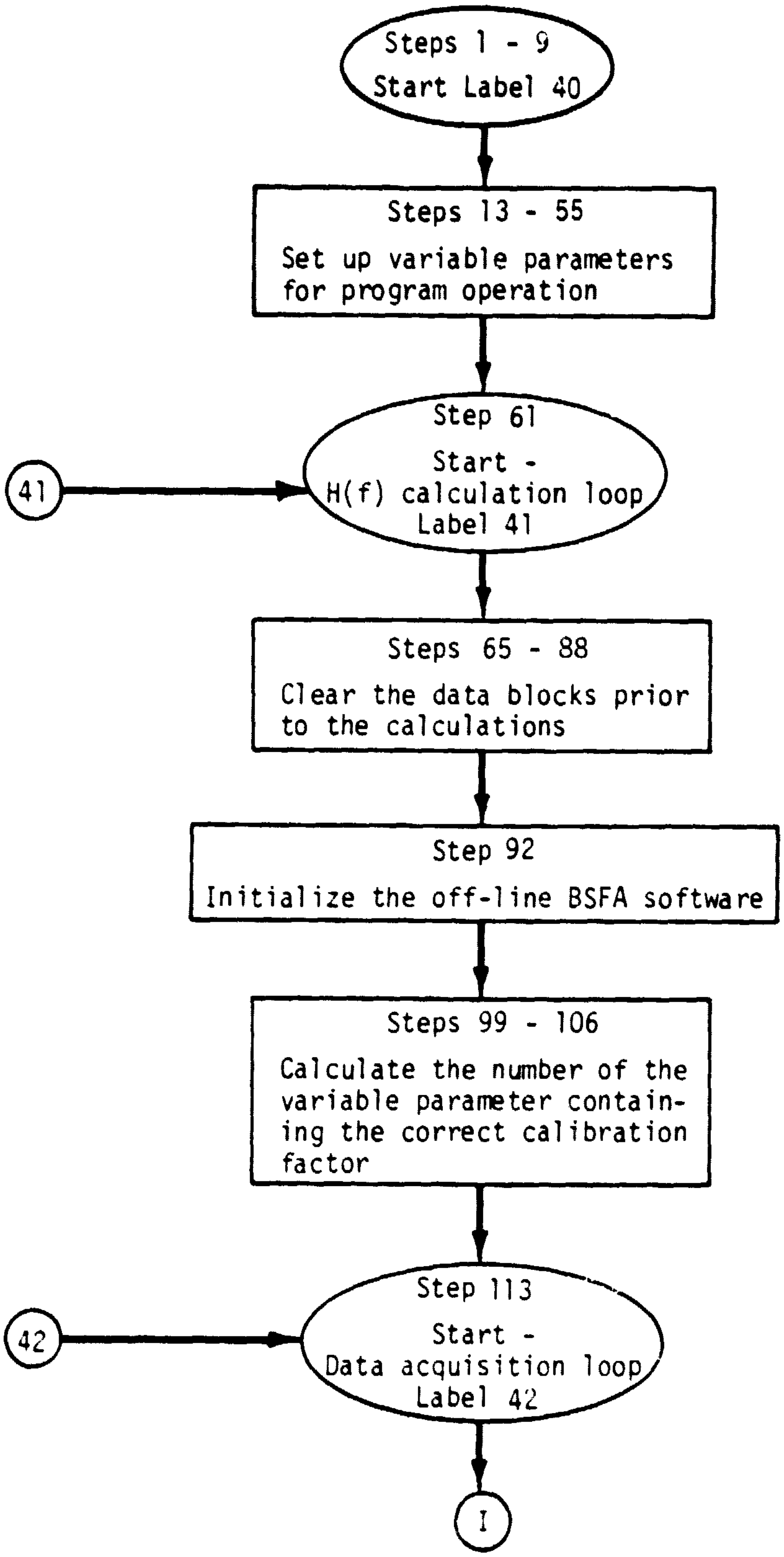


A12

POGO SOFTWARE BLANKING ROUTINE (Concluded)

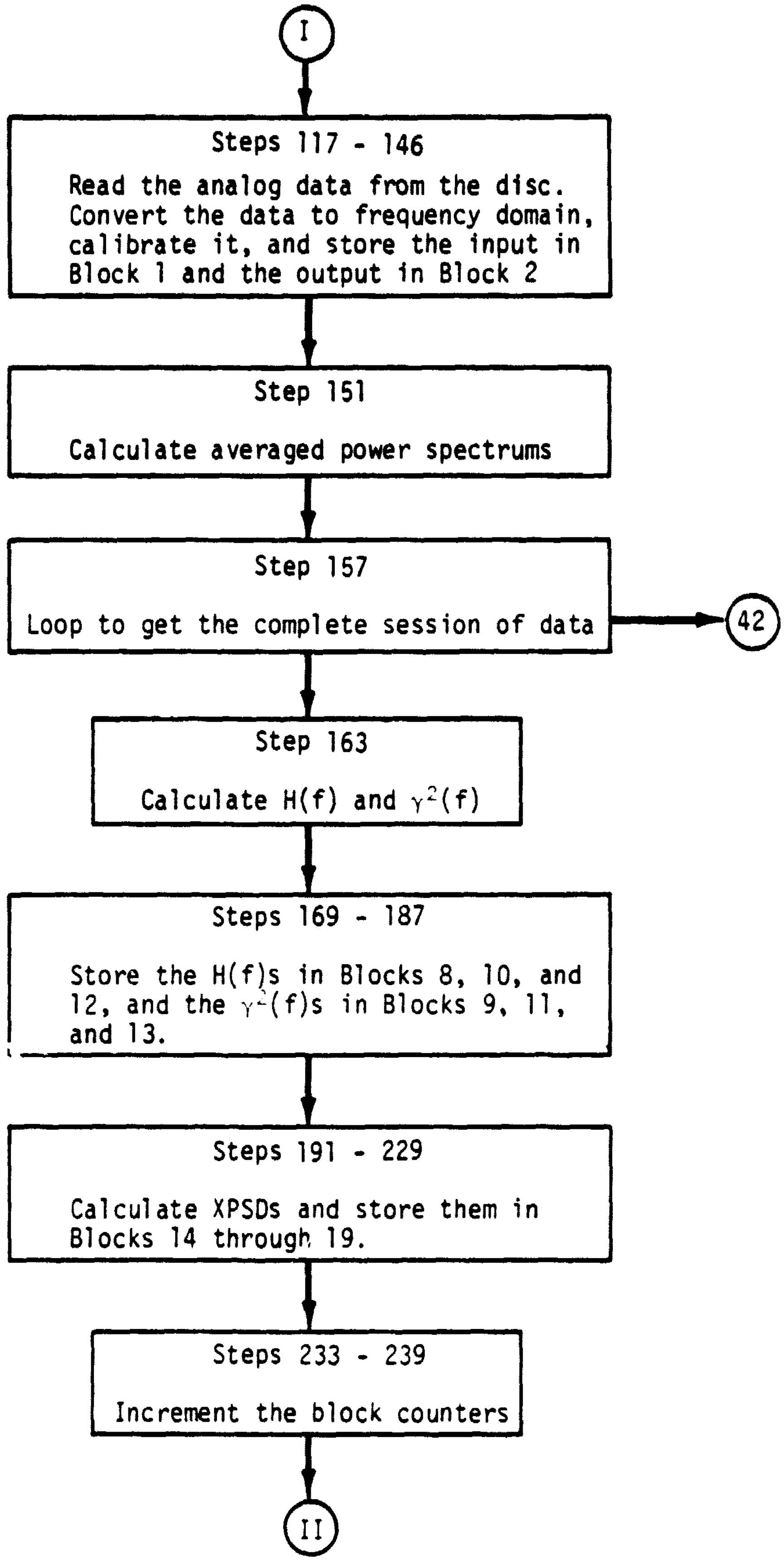


DIRECT POGO SOFTWARE FLOWCHART

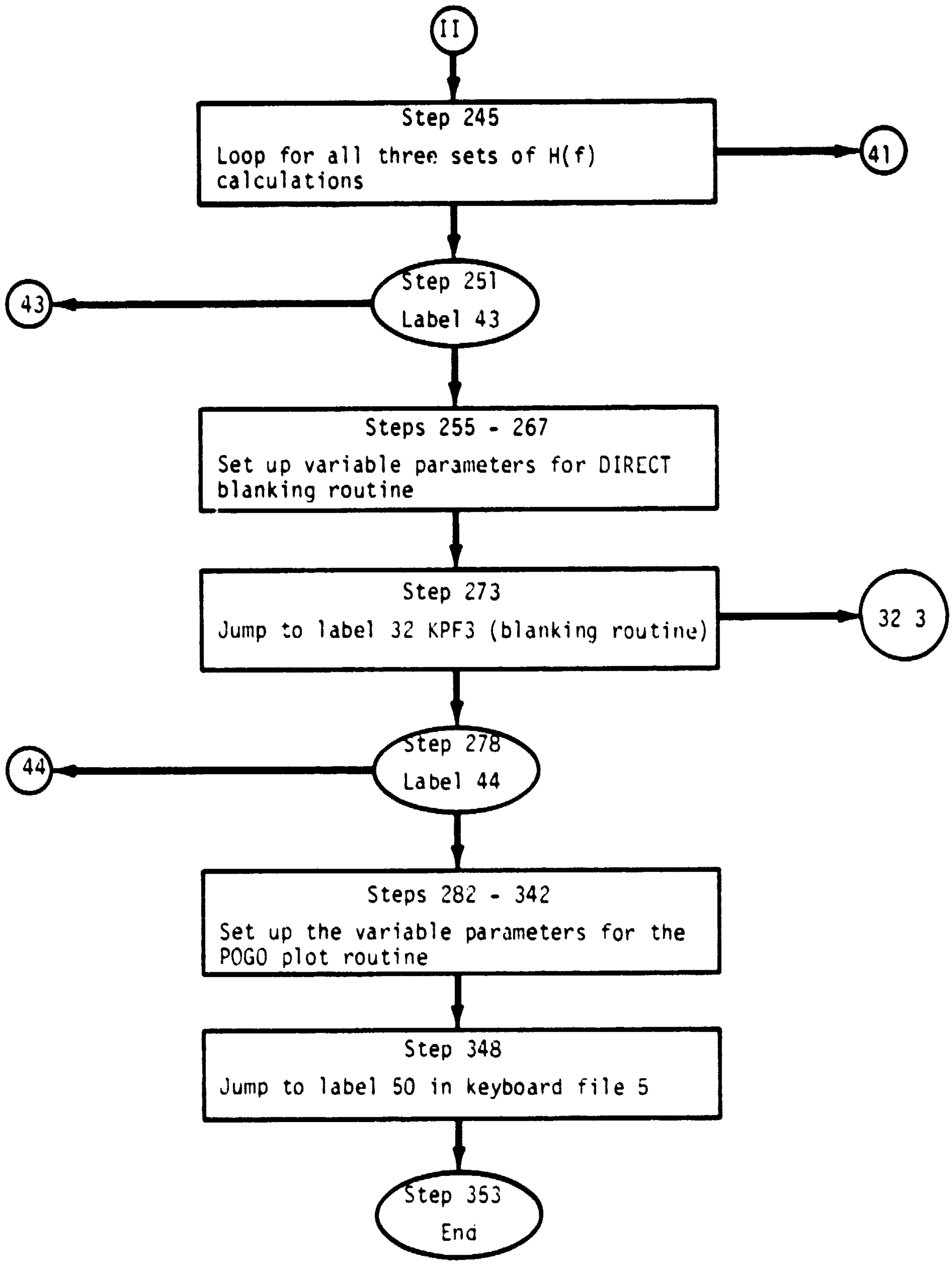


A14

DIRECT POGO SOFTWARE FLOWCHART (Continued)

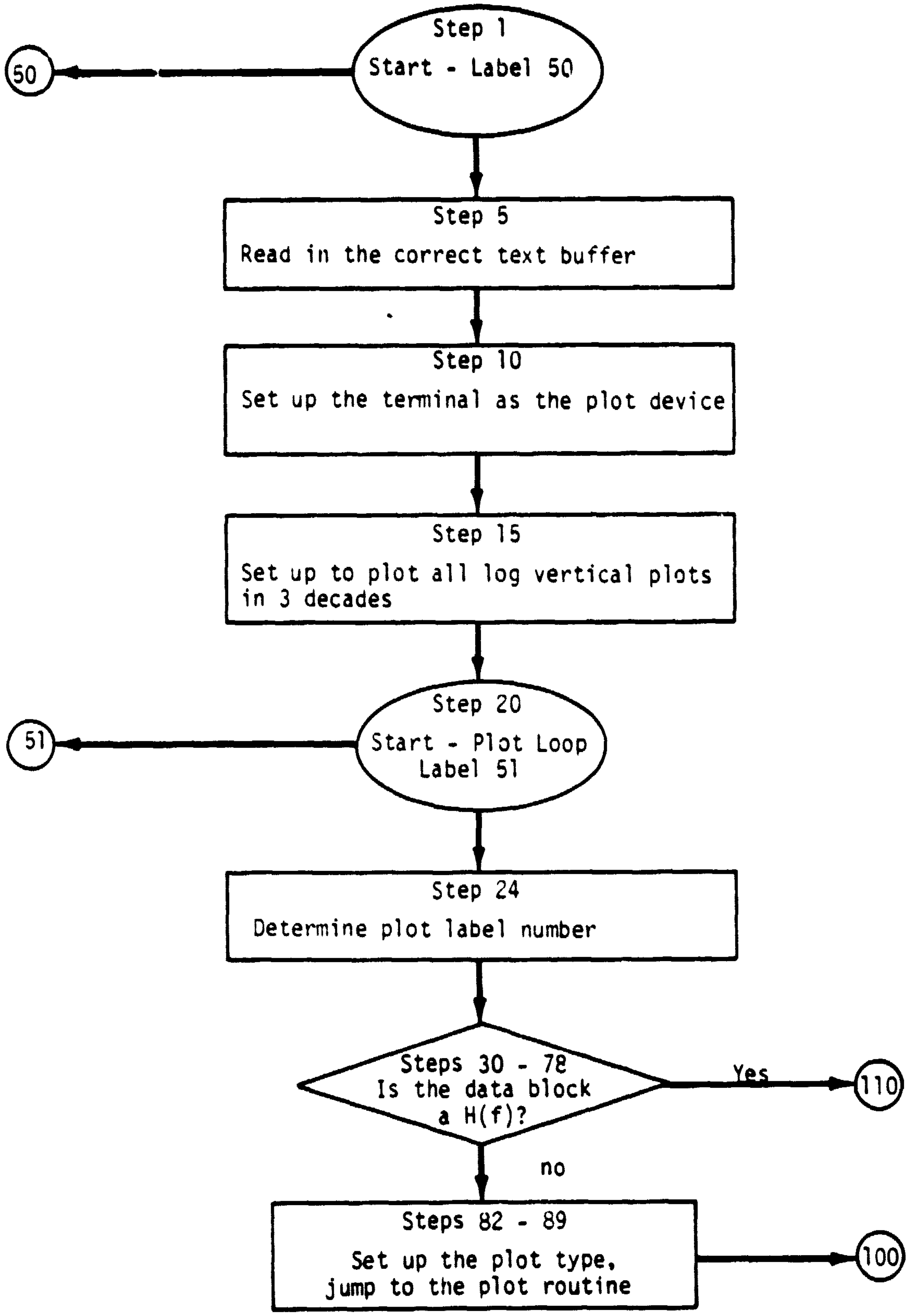


DIRECT POGO SOFTWARE FLOWCHART (Concluded)

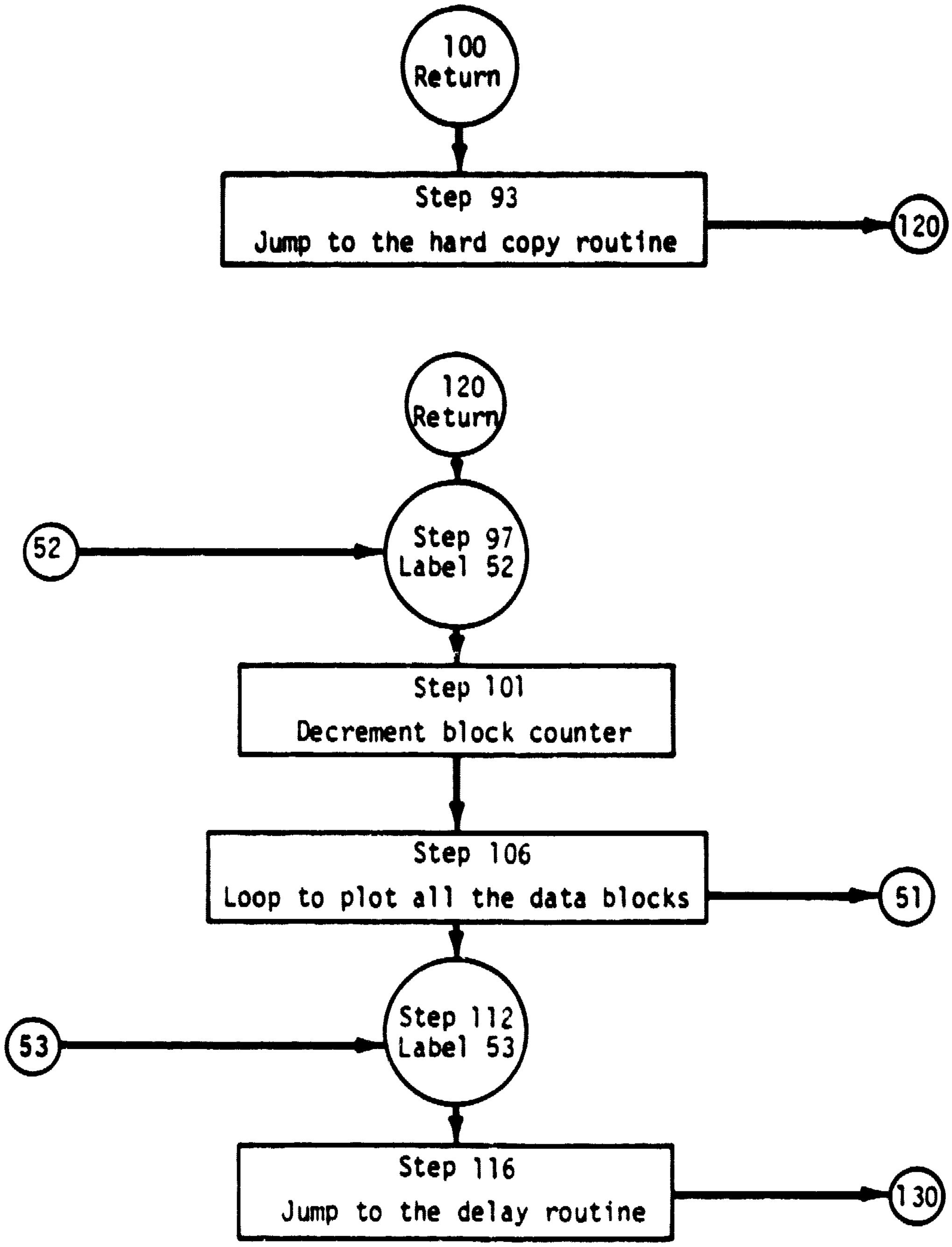


A16

POGO SOFTWARE PLOT ROUTINE

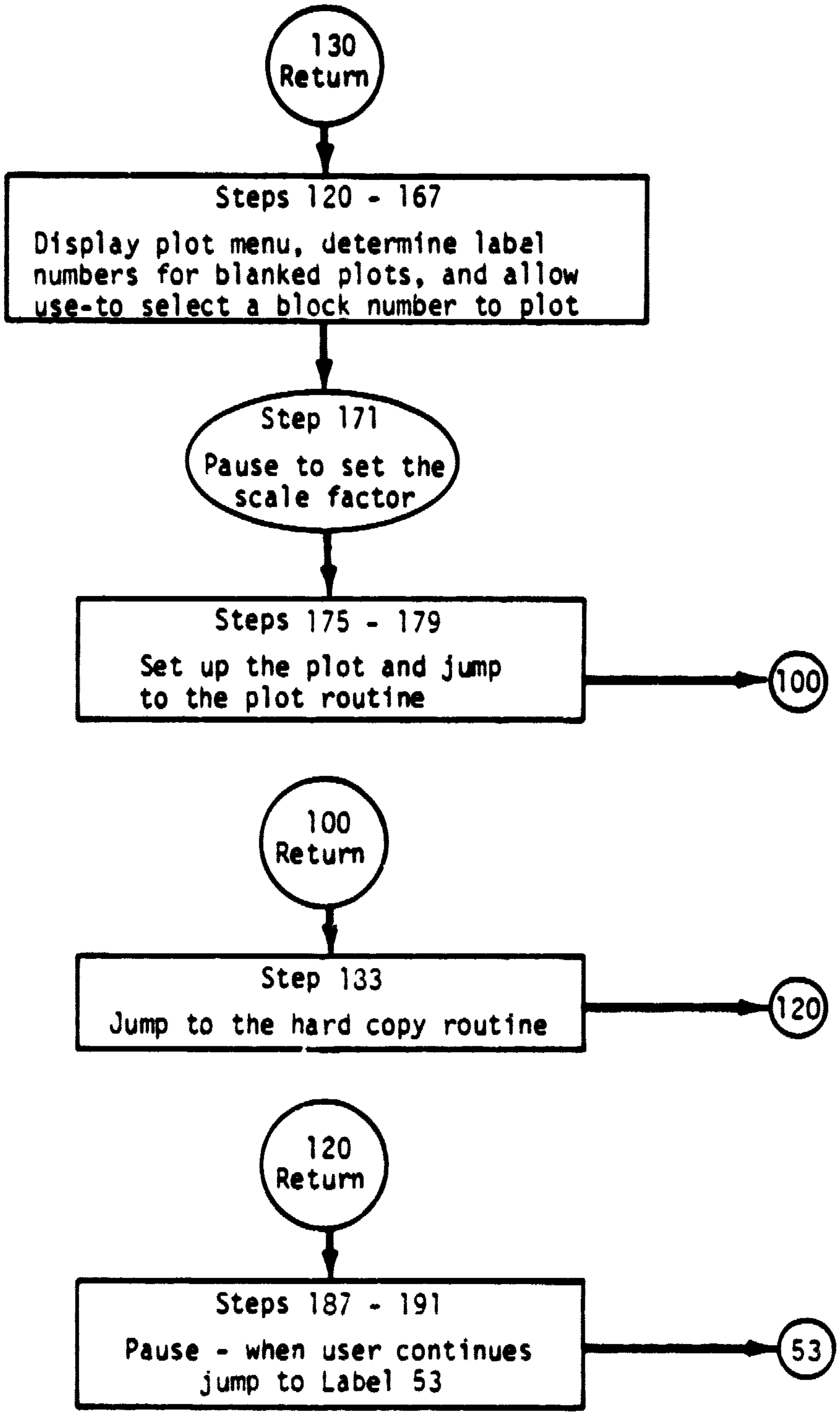


POGO SOFTWARE PLOT ROUTINE (Continued)

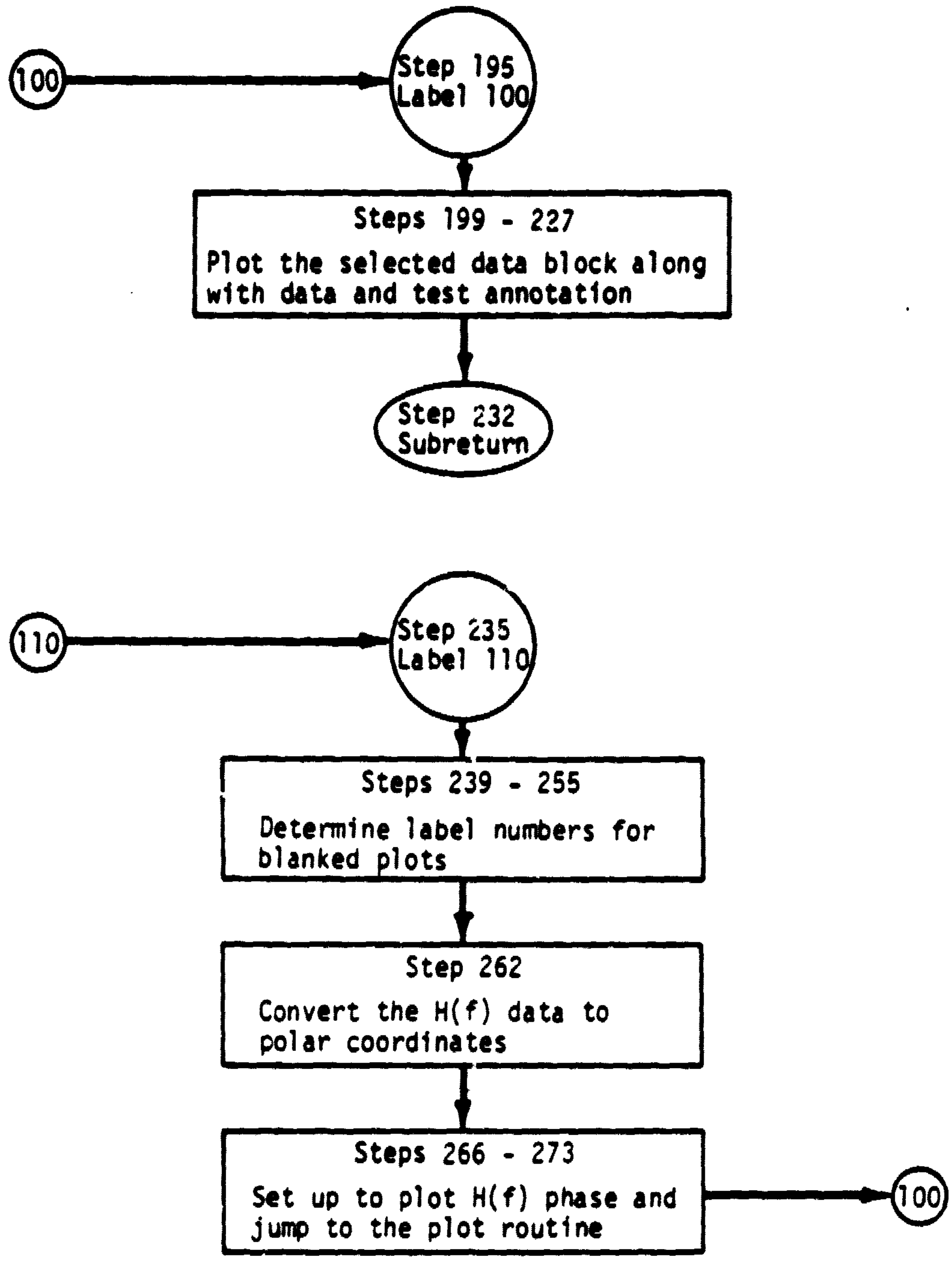


A18

POGO SOFTWARE PLOT ROUTINE (Continued)

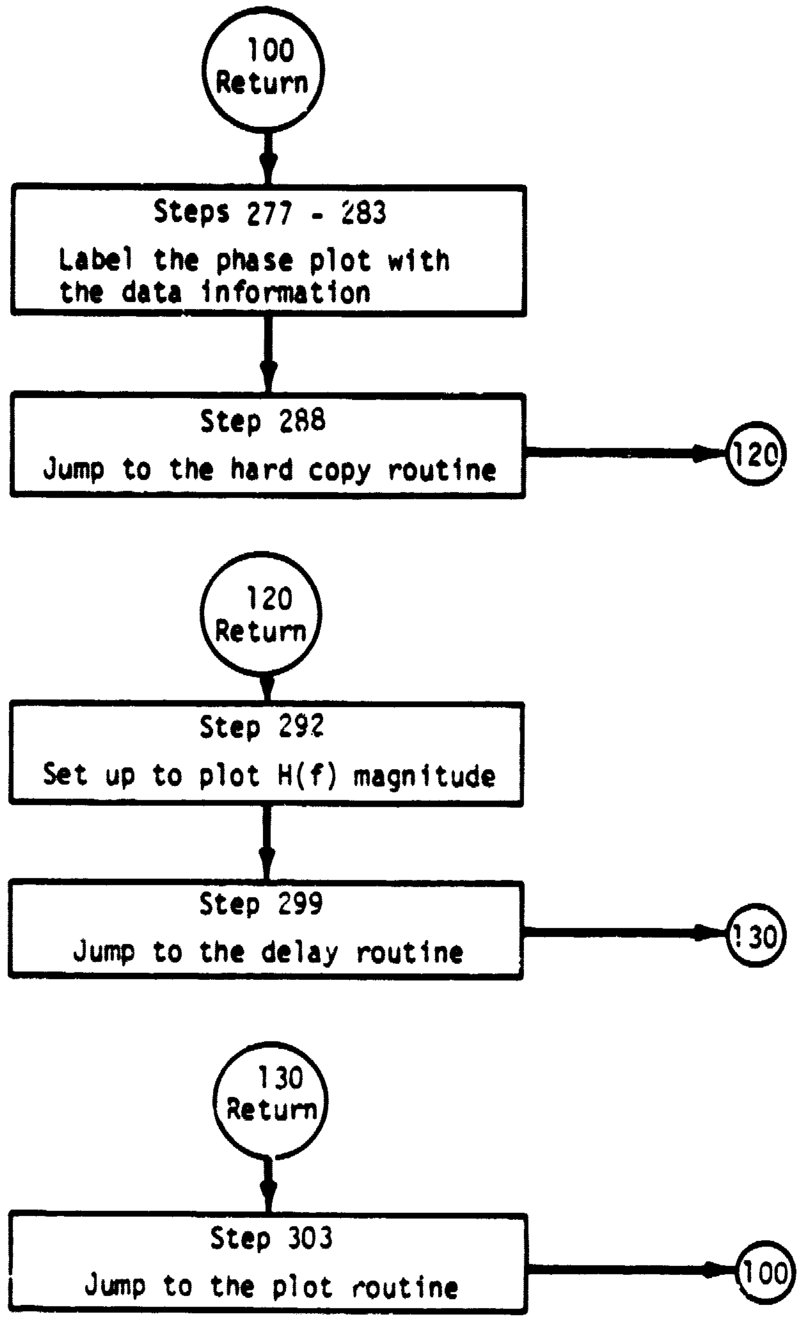


POGO SOFTWARE PLOT ROUTINE (Continued)

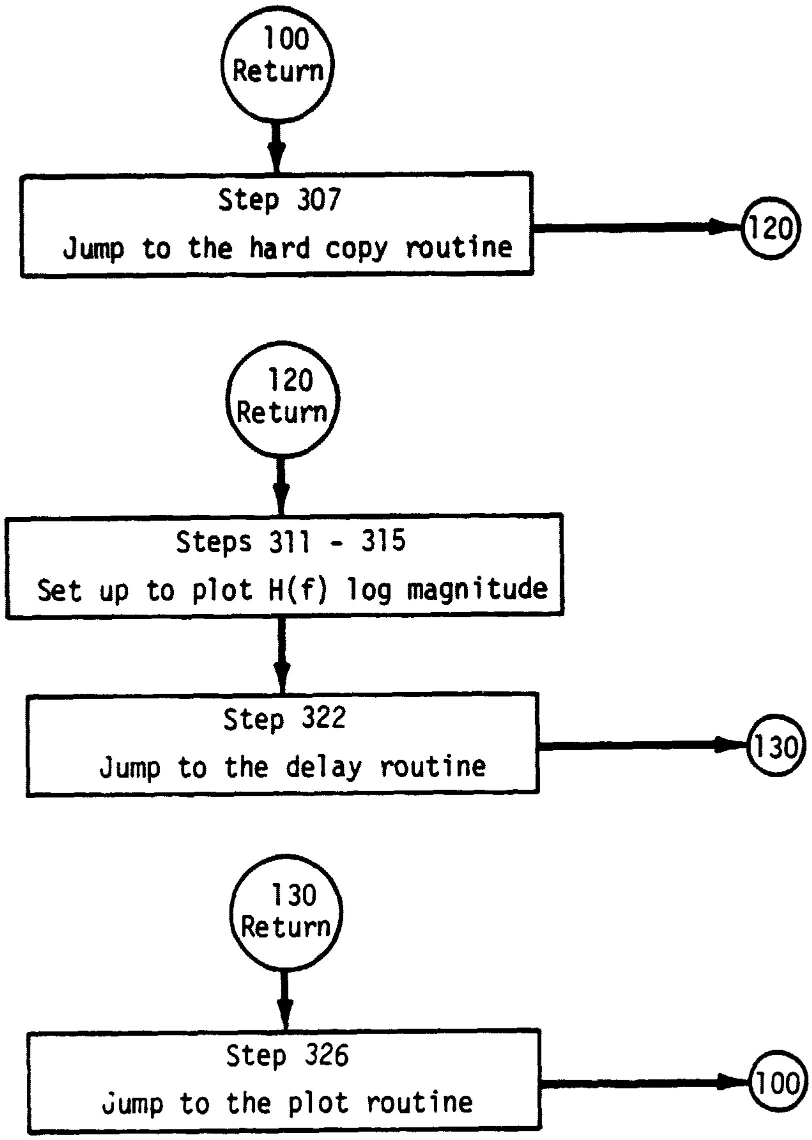


A20

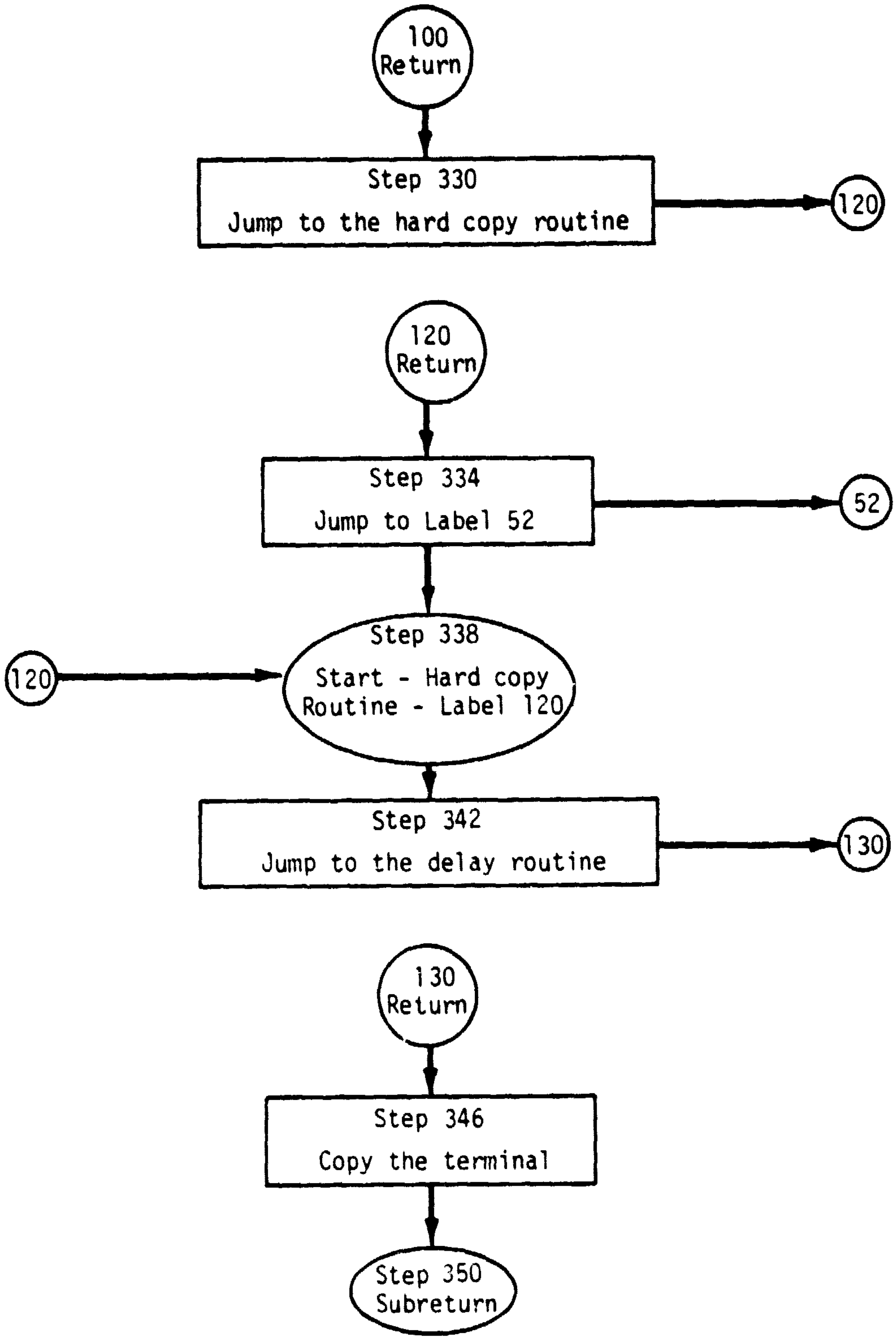
POGO SOFTWARE PLOT ROUTINE (Continued)



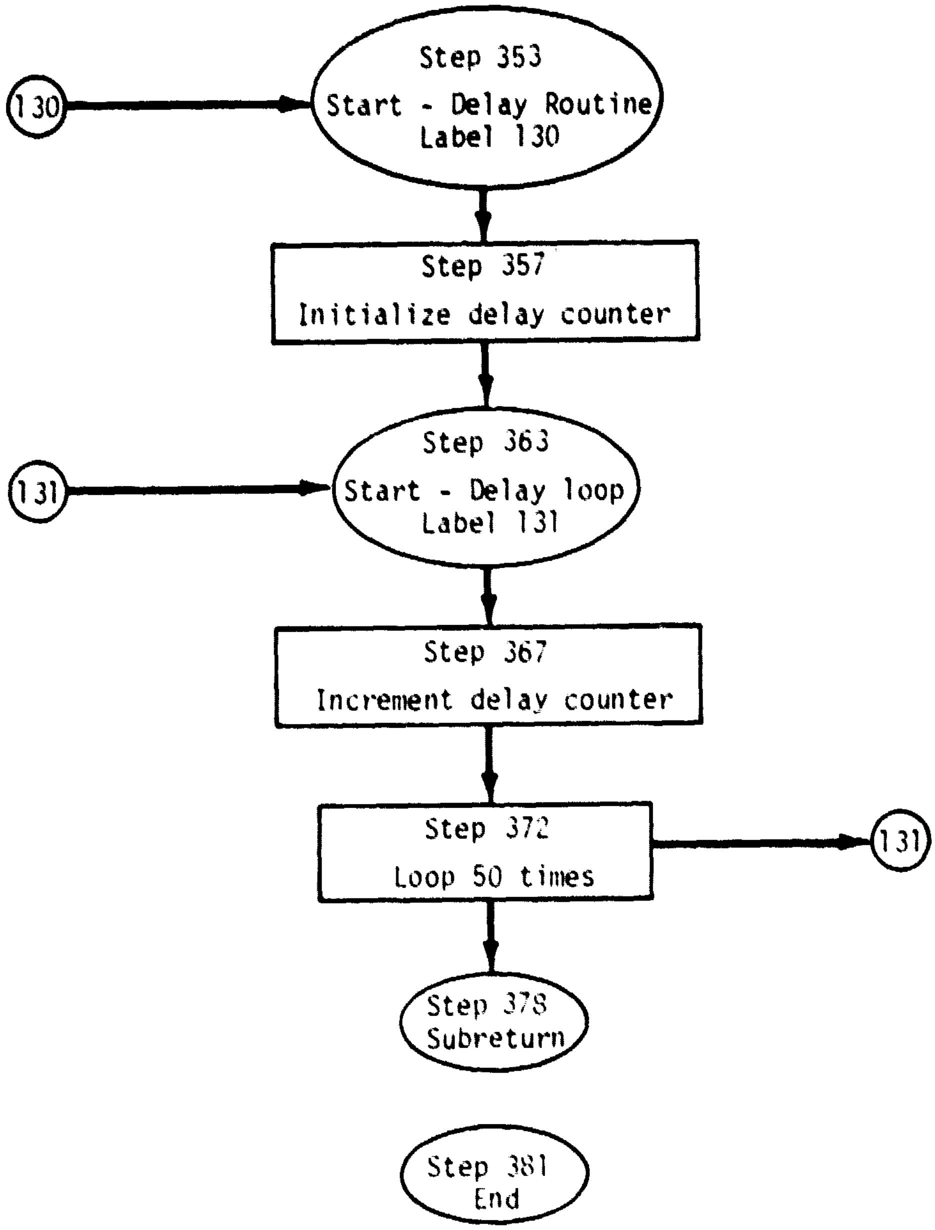
POGO SOFTWARE PLOT ROUTINE (Continued)



POGO SOFTWARE PLOT ROUTINE (Continued)



POGO SOFTWARE PLOT ROUTINE (Concluded)



APPENDIX B

POGO SOFTWARE LISTING

APPENDIX B

POGO SOFTWARE LISTING

KEYBOARD FILE 1 - RATIO POGO SOFTWARE PART 1

1	L	0			Label 0
5	BS	4096			Set blocksize to 4096
9	CL				
12	CL	1			
16	CL	2			
20	CL	3			Clear blocks 0 through 6
24	CL	4			
28	CL	5			
32	CL	6			
36	Y	5814			Call user program 5414 (blank terminal screen)
40	MS	34			Set text record pointer to zero (default)
44	MS	14			Read next text record (message #1)
48	Y R	1			Input from terminal VP1+ (blocksize)
53	BS	1D			Set blocksize to VP1
57	MS	14			Read next text record (message #2)
61	Y R	2000	2003		Input from terminal VP2000, VP2001, VP2002, and VP2003 (calibration factors)
67	Y *	2000	2000D	100	VP2000 = VP2000 * 100
74	Y *	2001	2001D	100	VP2001 = VP2001 * 100
81	Y *	2002	2002D	100	VP2002 = VP2002 * 100
88	Y *	2003	2003D	100	VP2003 = VP2003 * 100
95	MS	14			Read next text record (message #3)
99	Y R	2			Input from terminal VP2 (number of data acquisition loops)
104	MS	14			Read next text record (message #4)
108	Y R	2004			Input from terminal VP2004 (Δf)

+This means the variable of parameter 1.

KEYBOARD FILE 1 - RATIO POGO SOFTWARE PART 1 (Continued)

113 Y *	2004	2004D	10			VP2004 = VP2004 * 10
120 MS	34	20				Set text record pointer to 20
125 MS	14					Read next text record (message #7)
129 D						Display block 0 (used as program pause)
132 MS	32					Set ADC Throughput File pointer to 0
136 MS	22	4	2D			Write analog data to the ADC throughput file. No. of records = 2D (4 channels each)
142 L	10					Label 10
146 Y _	3	18				Set VP3 to 18
152 Y _	4	19				Set VP4 to 19
158 Y _	5	22				Set VP4 to 22
164 Y _	6	23				Set VP6 to 23
170 Y _	7	2				Set VP7 to 2
176 Y _	8	12				Set VP8 to 12
182 L	11					Label 11
186 CL						
189 CL	1					
193 CL	2					
197 CL	3					Clear blocks 0 through 6
201 CL	4					
205 CL	5					
209 CL	6					
213 Y _	9	3				Set VP9 to 3
219 Y A+	10	7D	1999			VP10 = VP7 + 1999
226 Y	41	0	0	0		Call user program 41; n1=0= center frequency of the band of interest, n2=0=width of the band of interest, n3=0=ADC throughput start record. (Initializes off-line BSFA)
233 L	12					Label 12
237 Y	45	2	0	7D		Call user program 45; n1=2=block number where the data will be stored, n2=0=number of Hannings applied to the data, n3=VP7= channel that will be read from the disc. (Off-line BSFA)

KEYBOARD FILE 1 - RATIO POGO SOFTWARE PART 1 (Continued)

244	Y	45	1	0	1	Call user program 45; n1=1, n2=0, n3=1
251	*	2	-10D			Multiply block 2 by VP(VP10)†
256	:	2	100			Divide block 2 by 100
261	*	1	2000D			Multiply block 1 by VP2000
266	:	1	100			Divide block 1 by 100
271	SP	1	2	2		Compute the average auto- and cross-power spectrums, where block n1=input data block and block n1+1=output, n2=2 specifies dual channel, n3=2 specifies double precision
277	#	12	2D	0		Loop through label 12 VP2 times
283	CH	1	2	2		Calculate transfer function data where n1=input data block, n2=2 specifies dual channel, n3=2 specifies double precision
289	X<	1				Load block 1 into block 0
293	X>	8D				Store block 0 into block VP8 [H(f)]
297	Y A+	8				VP8 = VP8 + 1
303	X<	2				Load block 2 into block 0
307	X>	8D				Store block 0 into VP8 [$\gamma^2(f)$]
311	L	13				Label 13
315	:	9D	2004D			Divide block VP9 by VP2004
320	*	9D	20			Multiply block VP9 by 20
325	X<	9D				Load block VP9 into block 0
329	X>	-9D				Store block 0 into block VP(VP9)
333	Y A+	9				VP9 = VP9 + 1
339	#	13	4	0		Loop through label 13 four times
345	Y A+	4				VP4 = VP4 + 1
351	Y A+	5	5D	2		VP5 = VP5 + 2
358	Y A+	6	6D	2		VP6 = VP6 + 2
365	Y A+	7				VP7 = VP7 + 1

†The minus sign in front of the VP number means to use the value in the VP that is specified by the value of the VP given (i.e., the value of the VP specified by VP10).

KEYBOARD FILE 1 - RATIO POGO SOFTWARE PART 1 (Concluded)

371 Y A+	8			VP8 = VP8 + 1
377 #	11	3	0	Loop through label 11 three times
383 J	20	2		Jump to label 20 in keyboard stack 2
388 .				End

KEYBOARD FILE 2 - RATIO POGO SOFTWARE PART 2

1	L	20			Label 20	
5	TR	12			Convert blocks 12	
9	TR	14			Convert blocks 14	to rectangular coordinates
13	TR	16			Convert blocks 16	
17	Y _	3	3		Set VP3 to 3	
23	Y _	4	6		Set VP4 to 6	
29	Y _	5	7		Set VP5 to 7	
35	Y _	6	14		Set VP6 to 14	
41	Y _	7	12		Set VP7 to 12	
47	Y _	8	16		Set VP8 to 16	
53	Y _	9	14		Set VP9 to 14	
59	Y _	10	16		Set VP10 to 16	
65	Y _	11	12		Set VP11 to 12	
71	Y _	12	13		Set VP12 to 13	
77	Y _	13	15		Set VP13 to 15	
83	Y :	14	1D	2	VP14 = VP1/2	
90	Y A+	14			VP14 = VP14 + 1	
95	Y _	15	17		Set VP15 to 17	
101	Y _	17	13		Set VP17 to 13	
107	L	21			Label 21	
111	Y TR	21	-5D	0	Get the block qualifiers from block VP(VP5) and put them in VP21 - VP25	
118	Y TR	21	3D	1	Put the block qualifiers stored in VP21 - VP25 into block VP3	
125	Y TR	21	4D	1	Put the block qualifiers into block VP4	
132	Y TR	21	-12D	0	Get the block qualifiers from block VP(VP12) and put them into VP21 - VP25	
139	Y TR	21	5D	1	Put the block qualifiers into block VP5	
146	Y _	0	0		Set VP0 to 0	
152	L	22			Label 22	
156	Y X<	3000	-4D	0D	Get the complex data from block VP(VP4), channel VP0, and put the values into complex VP3000	

KEYBOARD FILE 2 - RATIO POGO SOFTWARE PART 2 (Continued)

163	Y	X<	3001	-5D	0D		Get the complex data from block VP(VP5), channel VP0 and put them into complex VP3001
170	Y	X<	2005	12D	0D		Get the real data from block VP12, channel VP0 and put it into VP2005
177	Y	X<	2006	-12D	0D		Get the real data from block VP(VP12), channel VP0 and put it into VP2006
184	Y	IF	2005	0	7	0	If VP2005 = 0, skip seven steps
192	Y	:	2005	1	2005D		VP2005 = 1/VP2005
199	Y	If	2006	0	5	0	If VP2006 = 0, skip five steps
207	Y	:	2006	1	2006D		VP2006 = 1/VP2006
214	Y	A+	2007	2005D	2006D		VP2007 = VP2005 + VP2006
221	Y	A-	2007				VP2007 = VP2007 - 1
226	Y	:	2007	1	2007D		VP2007 = 1/VP2007
233	Y	IF	2007	0	1	2	If VP2007 > 0, skip one step
241	Y	_	2007	0			Set VP2007 to 0
247	Y	X>	2007	5D	0D		Put VP2007 into the real part of block VP5, channel VP0
254	Y	*	2009	2900D	2902D		VP2009 = VP2900 * VP2902 (ac)
261	Y	*	2010	2901D	2903D		VP2010 = VP2901 * VP2903 (bd)
268	Y	*	2011	2901D	2902D		VP2011 = VP2901 * VP2902 (bc)
275	Y	*	2012	2900D	2903D		VP2012 = VP2900 * VP2903 (ad)
282	Y	*	2013	2902D	2902D		VP2013 = $(VP2902)^2$ (c^2)
289	Y	*	2014	2903D	2903D		VP2014 = $(VP2903)^2$ (d^2)
296	Y	A+	2015	2013D	2014D		VP2015 = VP2013 + VP2014 (c^2+d^2)
303	Y	A+	2016	2009D	2010D		VP2016 = VP2009 + VP2010 (ac+bd)
310	Y	A-	2017	2011D	2012D		VP2017 = VP2009 - VP2012 (bc-ad)
317	Y	:	2904	2016D	2015D		VP2904 = VP2016/VP2015 $\left[\frac{(ac+bd)}{(c^2+d^2)}\right]$
324	Y	:	2905	2017D	2015D		VP2905 = VP2017/VP2015 $i\left[\frac{(bc-ad)}{(c^2+d^2)}\right]$
331	Y	IF	2904	7	1	2	If VP2094 > 7, skip one step
339	Y	IF	2904	-7	1	1	If VP2904 $\geq$ -7, skip one step
347	Y	_	2904	0			Set VP2904 to 0

KEYBOARD FILE 2 - RATIO POGO SOFTWARE PART 2 (Concluded)

353	Y IF	2905	7	1	2	If VP2905 > 7, skip one step
361	Y IF	2905	-7	1	1	If VP2905 ≥ -7, skip one step
369	Y _	2905	0			Set VP2905 to 0
375	Y X>	3002	4D	0D		Put complex VP3002 into block VP4, channel VP0
382	Y A+	0				VP0 = VP0 + 1
387	#	22	14D	0		Loop through label 22 VP14 times
393	Y A+	3				VP3 = VP3 + 1
398	Y A+	4	4D	2		VP4 = VP4 + 2
405	Y A+	5	5D	2		VP5 = VP5 + 2
412	Y A+	12	12D	2		VP12 = VP12 + 2
419	#	21	3	0		Loop through label 21 three times
425	J	30	3			Jump to label 30, keyboard stack 3
430	.					End

KEYBOARD FILE 3 - RATIO POGO SOFTWARE PART 3

1	L	30					Label 30
5	Y _	31	7				Set VP31 to 7
11	Y _	35	6				Set VP35 to 6
17	Y _	36	3				Set VP36 to 3
23	J	32					Jump to label 32
27	L	31					Label 31
31	Y _	3	1				Set VP3 to 1
37	Y _	4	27				Set VP4 to 27
43	Y _	5	16				Set VP5 to 16
49	Y _	6	14				Set VP6 to 14
55	Y _	7	12				Set VP7 to 12
61	Y _	8	10				Set VP8 to 10
67	Y _	9	8				Set VP9 to 8
73	Y _	10	6				Set VP10 to 6
79	Y _	11	25				Set VP11 to 25
85	Y _	12	24				Set VP12 to 24
91	Y _	13	125				Set VP13 to 125
97	J	50	5				Jump to label 50 in Keyboard File 5
102	L	32					Label 32
106	MS	34	82				Set the text record pointer to 82
111	MS	14					Read next text record (type of blanking routine
115	Y R	30					Input from terminal VP30
120	Y IF	30	0	1	2		IF VP30>0, skip 1 step
128	Y A+	31	31D	11			VP31 = VP31 + 11
135	X<	31D					Load blanking block (VP31)
139	MS	14					Read the next text record (minimum blanking value)
143	Y R	2030					Input from terminal VP2030
148	Y :	39	10D	2			VP39 = VP1/2
155	Y A-	39					VP39 = VP39 - 1
160	L	33					Label 33
164	TR	35D					

KEYBOARD FILE 3 - RATIO POGO SOFTWARE PART 3 (Concluded)

168	CL	36D					Clear block BP36
172	Y TR	21	35D	0			Get the block qualifiers from block VP35 and put them into VP21 - VP25
179	Y TR	21	36D	1			Put the block qualifiers stored in VP21-VP25 into block VP36
186	Y _	32	0				Set VP32 to 0
192	Y _	33	1				Set VP33 to 1
198	Y _	34	2				Set VP34 to 2
204	L	34					Label 34
208	Y _	3000	0				Set VP3000 to 0
214	Y X<	2032	31D	32D			Get the real data from block VP31, channel VP32 and store it in VP2032
221	Y X<	2033	31D	33D			Get the real data from block BP31, channel VP33 and store it in VP2033
228	Y X<	2034	31D	34D			Get the real data from block VP31, channel VP34 and store it in VP2034
235	Y IF	2033	2030D	3	-2		If VP2033<VP2030, skip 3 steps
243	Y IF	2033	2032D	2	-2		If VP2033<VP2032, skip 2 steps
251	Y IF	2033	2034D	1	-2		If VP2033<VP2034, skip 1 step
259	Y X<	3000	35D	33D			Get the complex data from block VP35, channel VP33 and store it in VP3000
266	Y X>	3000	36D	33D			Put the complex data stored in VP3000 into block VP36, channel VP33
273	Y A+	32					VP32 = VP32 + 1
278	Y A+	33					VP33 = VP33 + 1
283	Y A+	34					VP34 = VP34 + 1
288	#	34	39D				Loop through label 34 VP39 times
294	Y A+	35	35D	2			VP35 = VP35 + 2
301	Y A+	36					VP36 = VP36 + 1
306	Y A+	31	31D	30D			VP31 = VP31 + VP30
313	#	33	3				Loop through label 33 three times
319	<						Subreturn
322.							End

KEYBOARD FILE 4 - DIRECT POGO SOFTWARE

1	L	40				Label 40
5	X<	18				Load block 18 into block 0
9	X>	20				Store block 0 into block 20
13	Y _	3	8			Set VP3 to 8
19	Y _	4	14			Set VP4 to 14
25	Y _	8	3			Set VP8 to 3
31	Y _	10	4			Set VP10 to 4
37	Y _	12	4			Set VP12 to 4
43	Y _	14	2			Set VP14 to 2
49	Y _	16	3			Set VP16 to 3
55	Y _	18	2			Set VP18 to 2
61	L	41				Label 41
65	CL					
68	CL	1				
72	CL	2				
76	CL	3				Clear blocks 0 through 6
80	CL	4				
84	CL	5				
88	CL	6				
92	Y	41	0	0	0	Call User Program 41, where n1=n2=n3=0 (Initialize off-line BSFA)
99	Y A+	5	-4D	1999		VP5 = 1999 + VP(VP4)
106	Y A+	7	-3D	1999		VP7 = 1999 + VP(VP3)
113	L	42				Label 42
117	Y	45	2	0	-3D	Call User Program 45; n1=2, n2=0, n3=VP(VP3) (off-line BSFA)
124	Y	45	1	0	-4D	Call User Program 45; n1=1, n2=0, n3=VP(VP4)
131	*	2	-7D			Multiply block 2 by VP(VP7)
136	:	2	100			Divide block 2 by 100
141	*	1	-5D			Multiply block 1 by VP(VP5)
146	:	1	100			Divide block 1 by 100
151	SP	1	2	2		Calculate averaged 2-channel-double precision power spectrum

KEYBOARD FILE 4 - DIRECT POGO SOFTWARE (Continued)

157 #	42	2D	0		Loop through label 42 VP2 times
163 CH	1	2	2		Calculate H(f) and γ^2(f) from the averaged power spectrum data
169 X<	1				Load block 1 into block 0 [H(f)]
173 X>	3D				Store block 0 into block VP3
177 Y A+	3				VP3 = VP3 + 1
183 X<	2				Load block 2 into block 0 [γ^2(f)]
187 X>	3D				Store block 0 in block VP3
191 :	5	2004D			Divide block 5 by VP2004
196 *	5	20			Multiply block 5 by 20
201 :	6	2004D			Divide block 6 by VP2004
206 *	6	20			Multiply block 6 by 20
211 X<	5				Load block 5 into block 0
215 X>	4D				Store block 0 in block VP4
219 Y A+	4				VP4 = VP4 + 1
225 X<	6				Load block 6 into block 0
229 X>	4D				Store block 0 into block VP4
233 Y A+	3				VP3 = VP3 + 1
239 Y A+	4				VP4 = VP4 + 1
245 #	41	3	0		Loop through label 41 three times
251 L	43				Label 43
255 Y _	31	9			Set VP31 to 9
261 Y _	35	8			Set VP35 to 8
267 Y _	36	5			Set VP36 to 5
273 J	32	3			Jump to label 33 in Keyboard File 3
278 L	44				Label 44
282 Y _	3	2			Set VP3 to 2
288 Y _	4	19			Set VP4 to 19
294 Y _	5	12			Set VP5 to 12
300 Y _	6	10			Set VP6 to 10
306 Y _	7	8			Set VP7 to 8
312 Y _	8	8			Set VP8 to 8
318 Y _	9	8			Set VP9 to 8

B12

KEYBOARD FILE 4 - DIRECT POGO SOFTWARE (Concluded)

324 Y _		10	8	Set VP10 to 8
330 Y _		11	15	Set VP11 to 15
336 Y _		12	58	Set VP12 to 58
342 Y _		13	150	Set VP13 to 150
348 J	50		5	Jump to lable 50 in Keyboard File 5 (Plot Routine)
353 .				End

KEYBOARD FILE 5 - POGO PLOT ROUTINE

1	L	50					Label 50
5	Y	5838	3D				Call User Program 5838; n1=VP3 (Read text buffer VP3 into core)
10	Y	5821	6				Call User Program 5821; n1=6 (Set up the terminal as the plot device)
15	Y	5865	3				Call User Program 5865; n1=3 (Set log plots to plot 3 decades, vertical scale)
20	L	51					Label 51
24	Y _	26	4D				Set VP26 to the value of VP4
30	Y IF	4	5D	5	0		If VP4 = VP5, skip five steps
38	Y IF	4	6D	4	0		If VP4 = VP6, skip four steps
46	Y IF	4	7D	3	0		If VP4 = VP7, skip three steps
54	Y IF	4	8D	2	0		If VP4 = VP8, skip two steps
62	Y IF	4	9D	1	0		If VP4 = VP9, skip one step
70	Y IF	4	10D	1	2		If VP4 > VP10, skip one step
78	J	110					Jump to label 110
82	Y	5809	0	0	0		Call User Program 5809; n1=0, n2=0, n3=0 (Set up to plot real/magnitude, linear horizontal scale, scale switch at 12 o'clock)
89	J	100					Jump to label 100
93	J	120					Jump to label 120
97	L	52					Label 52
101	Y A-	4					VP4 = VP4 - 1
106	#	51	11D	0			Loop through label 51 VP11 times
112	L	53					Label 53
116	J	130					Jump to label 130
120	Y	5814					Call User Program 5814 (Blank the terminal screen)
124	MS	34	12D				Set the text record pointer to VP12
129	MS	14					Read the next message (plot menu)
133	Y R	4					Input VP4 (data block number to be plotted

KEYBOARD FILE 5 - POGO PLOT ROUTINE (Continued)

138	Y _	26	4D			Set VP26 to the value of VP4
144	Y IF	4	10D	2	1	If VP4 ≥ VP10, skip 2 steps
152	Y IF	30	0	1	0	If VP30 = 0, skip 1 step
160	Y A+	26	26D	30		VP26 = VP26 + 30
167	MS	14				Read the next message (Set the scale and press "CONTINUE")
171	D	4D				Display block VP4
175	Y	5809				Call User Program 5809; n1=n2=n3=default (Set up the plot according to the display switches)
179	J	100				Jump to label 100
183	J	120				Jump to label 120
187	D	4D				Display block VP4
191	J	53				Jump to label 53
195	L	100				Label 100
199	Y	5814				Call User Program 5814
203	Y	5829				Call User Program 5829 (Plot the full data block)
207	Y	5815	4D			Call User Program 5815; n1=VP4 (Plot the data from block VP4)
212	Y	5816				Call User Program 5816 (Plot the defaulted axis)
216	Y	5817	26D			Call User Program 5817; n1=VP26 (Label the vertical axis with text buffer message VP4 and the horizontal axis with the default label)
221	Y	5808	975	600		Call User Program 5808; n1=970, n2=600 (Position the cursor to y=97.0% of the vertical plot window and x=60.0% of the horizontal plot window)
227	Y	5819	1			Write text buffer message #1
232	<					Subreturn
235	L	110				Label 110
239	Y IF	4	10D	2	1	If VP4 ≥ VP10, skip 2 steps
247	Y IF	30	0	1	0	If VP30 = 0, skip 1 step

KEYBOARD FILE 5 - POGO PLOT ROUTINE (Concluded)

255	Y A+	26	26D	30		VP26 = VP26 + 30
262	TP	4D				Convert block VP4 to polar coordinates
266	Y	5809	1	0	0	Call User Program 5809; n1=1, n2=0, n3=0 (Set up to plot imaginary/phase, linear horizontal, scale switch to 12 o'clock)
273	J	100				Jump to label 100
277	Y	5808	970	13D		Call User Program 5808; n1=970, n2=VP13
283	Y	5819	26D			Call User Program 5819; n1=VP26
288	J	120				Jump to label 120
292	Y	5809	0	0	0	Call User Program 5809; n1=0, n2=0, n3=0
299	J	130				Jump to label 130
303	J	100				Jump to label 100
307	J	120				Jump to label 120
311	TL	4D				Convert block VP4 to log polar coordinates
315	Y	5809	0	0	0	Call User Program 5809; n1=0, n2=0, n3=0
322	J	130				Jump to label 130
326	J	100				Jump to label 100
330	J	120				Jump to label 120
334	J	52				Jump to label 52
338	L	120				Label 120
342	J	130				Jump to label 130
346	Y	5820				Call User Program 5820 (Hard copy the terminal)
350	<					Subreturn
353	L	130				Label 130
357	Y _	19	1			Set VP19 to 1
363	L	131				Label 131
367	Y A+	19				VP19 = VP19 + 1
372	#	131	50	0		Loop through label 131 fifty times
378	<					Subreturn
381	.					End

APPENDIX C

POGO SOFTWARE TEXT RECORDS (FILE 4a)

APPENDIX C

POGO SOFTWARE TEXT RECORDS (FILE 4a)

Line #	Contents
	Message #1
0	
1	This is a 5451C program, written for POGO data analysis. The program
2	reads 4 analog channels simultaneously and writes them directly to the
3	disc via the ADC Throughput. The time domain data is then called from
4	the disc and H(f)s calculated re. Pulser. H(f)s across devices are
5	calculated by ratios. 28 JANUARY 80
6	
7	Setup the ADC for the desired frequency resolution (Delta f), and
8	input signal-to-noise ratio. Then, enter Blocksize. (INTEGER LE 1024)
9	/*
	Message #2
10	Enter a calibration factor for each channel. (4 - FLOATING POINT)
11	/*
	Message #3
12	Enter the number of data acquisition loops. (INTEGER)
13	/*
	Message #4
14	Enter Delta f as specified by the ADC. (FLOATING POINT)
15	/*
	Message #7
20	Start the data tape. Press "CONTINUE."
21	/*

C2

Line #   Contents

Message #8

RATIO POGO DATA PLOT MENU

```
The program output is located in core memory as follows:

  BLOCK#          DATA

      3    Weighted H(f) HPOP/LPOP
      4    Weighted H(f) MCC/HPOP
      5    Weighted H(f) MCC/LPOP
      6    H(f)     HPOP/LPOP
      7    Coh(f)       "
      8    H(f)     MCC/HPOP
      9    Coh(f)      "
     10    H(f)     MCC/LPOP
     11    Coh(f)      "
     12    H(f)     LPOP/Pulser
     13    Coh(f)       "
     14    H(f)     HPOP/Pulser
     15    Coh(f)       "
     16    H(f)     MCC/Pulser
     17    Coh(f)      "
     18    PSD      Pulser
     19    PSD      LPOP
     20    PSD      HPOP
     21    PSD      MCC
     22    Re XPSD LPOP/Pulser
     23    Im XPSD      "
     24    Re XPSD HPOP/Pulser
     25    Im XPSD      "
     26    Re XPSD MCC/Pulser
     27    Im XPSD     "

Please enter the Block# you wish to plot.
/*
```

Message #9

```
Set the scale and press "CONTINUE."
/*
```

```
Line #                          Contents

                               Message #10

                         DIRECT POGO DATA PLOT MENU

 58      The program output is located in core as follows:
 59
 60          BLOCK#          DATA
 61
 62             5    Weighted H(f) HPOP/LPOP
 63             6    Weighted H(f) MCC/HPOP
 64             7    Weighted H(f) MCC/LPOP
 65             8    H(f)     HPOP/LPOP
 66             9    Coh(f)        "
 67            10    H(f)     MCC/HPOP
 68            11    Coh(f)       "
 69            12    H(f)     MCC/LPOP
 70            13    Coh(f)       "
 71            14    Re XPSD HPOP/LPOP
 72            15    Im XPSD      "
 73            16    Re XPSD MCC/HPOP
 74            17    Im XPSD     "
 75            18    Re XPSD MCC/LPOP
 76            19    Im XPSD     "
 77
 78      Please enter the block # you wish to plot.
 79      /*

                               Message #11

 80      Set the scale and press "CONTINUE".
 81      /*

                               Message #12

 82      Do you want:  Coherence blanking (enter 2)
 83                    Pulser blanking (enter 0)?
 84      /*

                               Message #13

 85      Enter the minimum blanking value (floating point).
 86      /*
```

APPENDIX D

POGO SOFTWARE TEXT BUFFERS (FILE 4b)

APPENDIX D

POGO SOFTWARE TEXT BUFFERS (FILE 4b)

Text Buffer #1

RATIO POGO PLOT LABELS

```
01
(TEST ID)
/*

13
  HPOP/LPOP Ratio H(f)
  Pulser Blanked
/*

04
  MCC/HPOP Ratio H(f)
  Pulser Blanked
/*

05
  MCC/LPOP Ratio H(f)
  Pulser Blanked
/*

06
  HPOP/LPOP Ratio H(f) - Polar
/*

07
  HPOP/LPOP Ratio Coh(f)
/*

08
  MCC/HPOP Ratio H(f) - Polar
/*

09
  MCC/HPOP Ratio Coh(f)
/*

10
  MCC/LPOP Ratio H(f) - Polar
/*

11
  MCC/LPOP Ratio Coh(f)
/*
```

Text Buffer #1 (Continued)

```
12
 LPOP/Pulser H(f) - Polar
/*

13
 LPOP/Pulser Coh(f)
/*

14
 HPOP/Pulser H(f) - Polar
/*

15
 HPOP/Pulser Coh(f)
/*

16
 MCC/Pulser H(f) - Polar
/*

17
 MCC/Pulser Coh(f)
/*

18
 Pulser PSD
/*

19
 LPOP PSD
/*

20
 HPOP PSD
/*

21
 MCC PSD
/*

22
 LPOP/Pulser Real XPSD
/*

23
 LPOP/Pulser Imag XPSD
/*

24
 HPOP/Pulser Real XPSD
/*
```

Text Buffer #1 (Concluded)

```
25
  HPOP/Pulser Imag XPSD
/*

26
  MCC/Pulser Real XPSD
/*

27
  MCC/Pulser Imag XPSD
/*

33
  HPOP/LPOP Ratio H(f)
  Coherence Blanked
/*

34
  MCC/HPOP Ratio H(f)
  Coherence Blanked
/*

35
  MCC/LPOP Ratio H(f)
  Coherence Blanked
/*
```

Text Buffer #2

DIRECT POGO PLOT LABELS

```
01
(TEST ID)
/*

05
  HPOP/LPOP Direct H(f)
  Pulser Blanked
/*

06
  MCC/HPOP Direct H(f)
  Pulser Blanked
/*

07
  MCC/LPOP Direct H(f)
  Pulser Blanked
/*
```

D4

Text Buffer #2 (Continued)

```
08
  HPOP/LPOP Direct H(f) - Polar
/*

09
  HPOP/LPOP Direct Coh(f)
/*

10
  MCC/HPOP Direct H(f) - Polar
/*

11
  MCC/HPOP Direct Coh(f)
/*

12
  MCC/LPOP Direct H(f) - Polar
/*

13
  MCC/LPOP Direct Coh(f)
/*

14
  HPOP/LPOP Direct Real XPSD
/*

15
  HPOP/LPOP Direct Imag XPSD
/*

16
  MCC/HPOP Direct Real XPSD
/*

17
  MCC/HPOP Direct Imag XPSD
/*

18
  MCC/LPOP Direct Real XPSD
/*

19
  MCC/LPOP Direct Imag XPSD
/*

35
  HPOP/LPOP Direct H(f)
  Coherence Blanked
/*
```

Text Buffer #2 (Concluded)

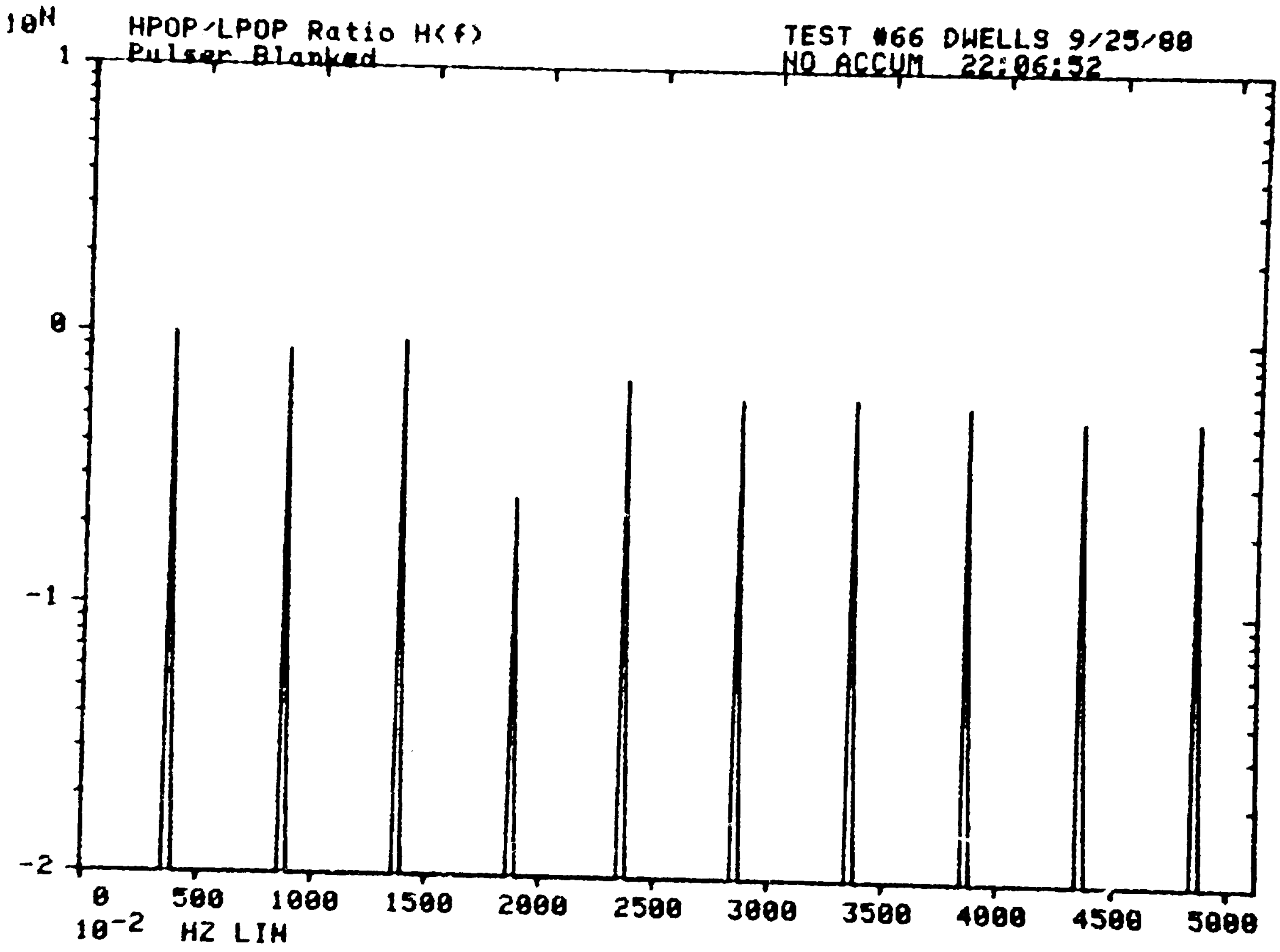
```
36
  MCC/HPOP Direct H(f)
  Coherence Blanked
/*

37
  MCC/LPOP Direct H(f)
  Coherence Blanked
/*
```

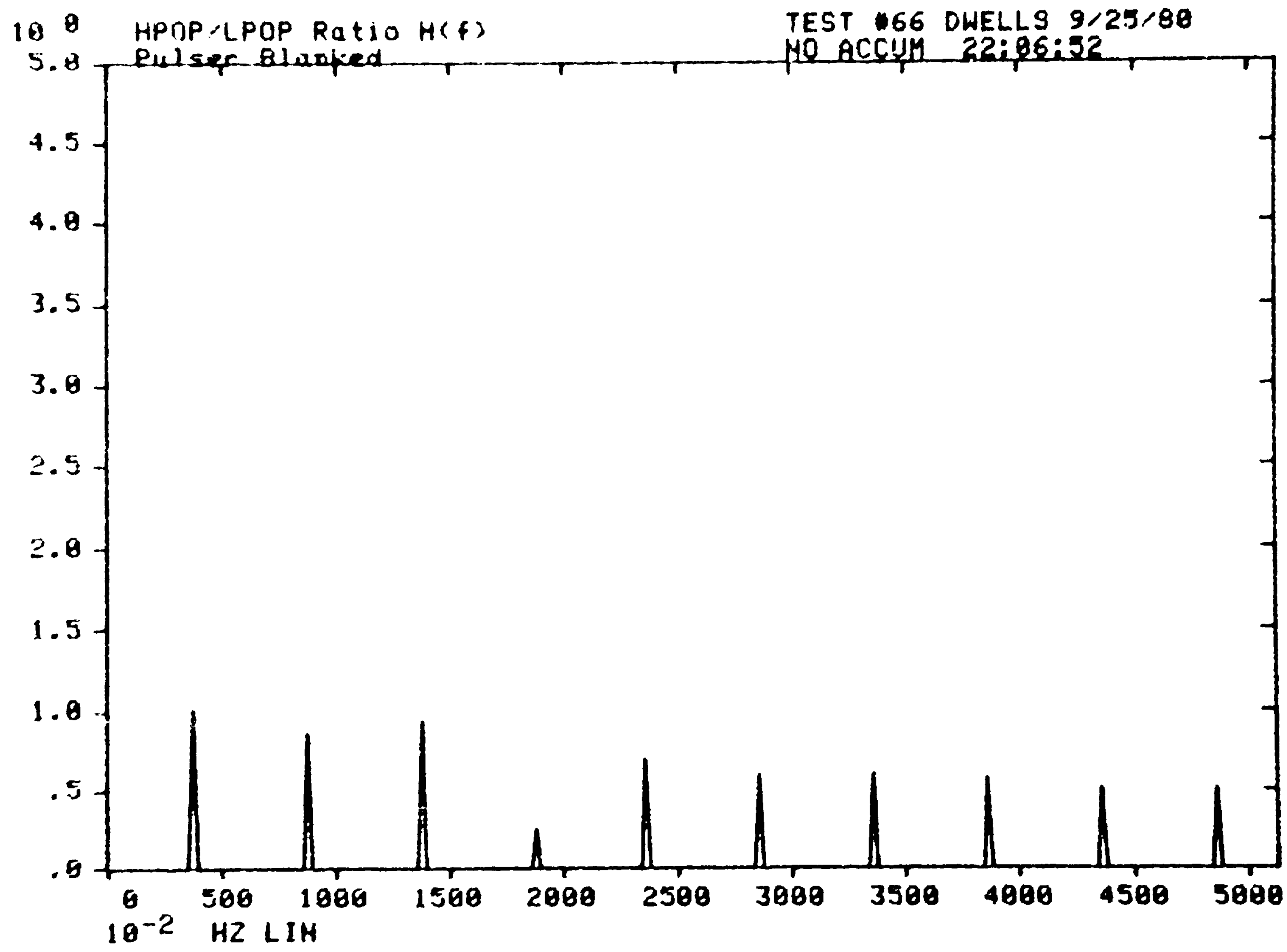
APPENDIX E

POGO SOFTWARE SAMPLE OUTPUT

66

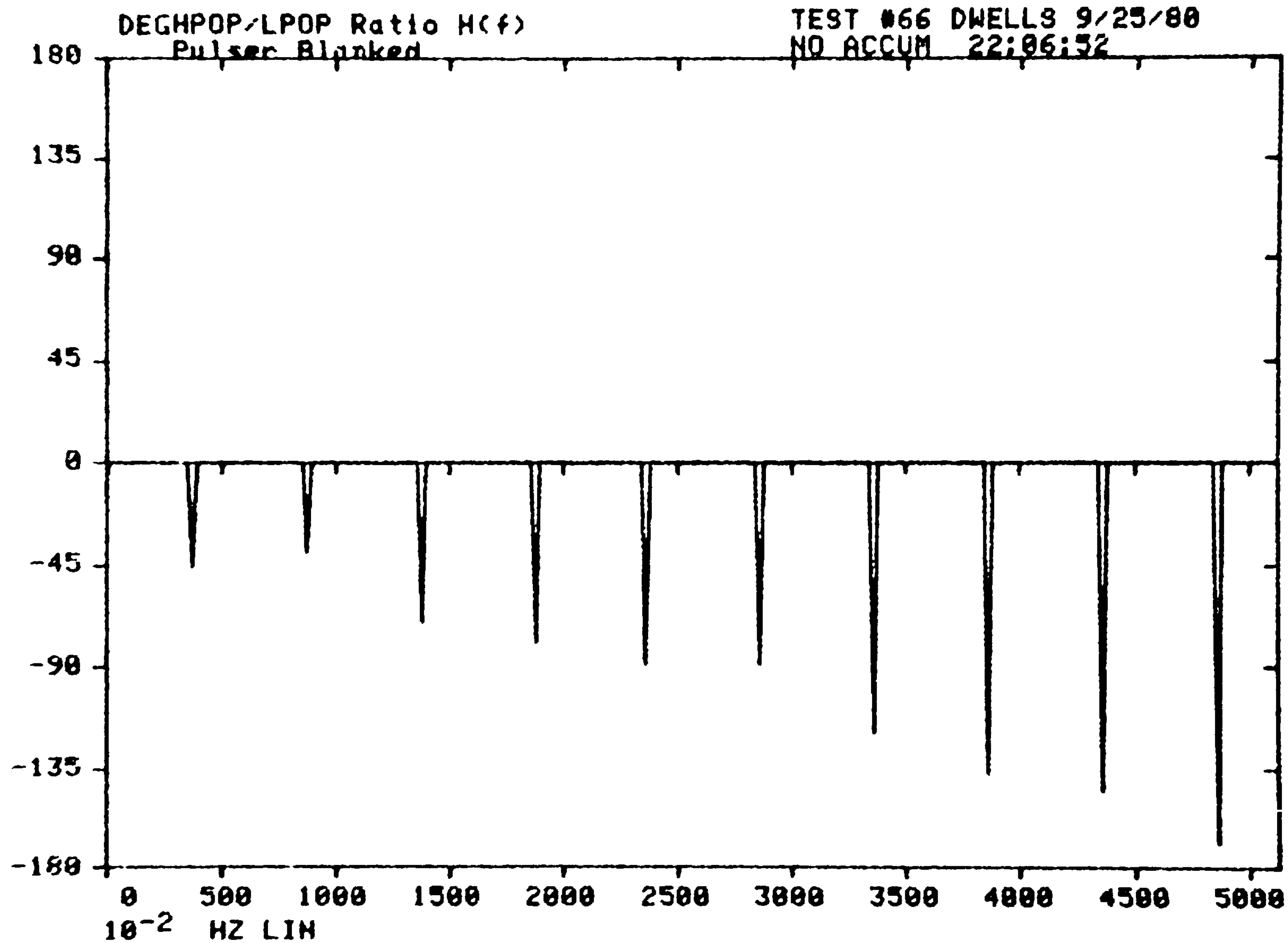
```
*************************************************************************
This is a 5451C program, written for POGO data analysis.  The program
reads 4 analog channels simultaneously and writes them directly to the
disc via the ADC Throughput.  The time domain data is then called from
the disc and H(f)s calculated re. Pulser.  H(f)s across devices are
calculated by ratios.                                      28 JANUARY 80
*************************************************************************
Setup the ADC for the desired frequency resolution (Delta f), and
input signal-to-noise ratio.  Then, enter Blocksize. (INTEGER LE 1024)
512

Enter a calibration factor for each channel.  (4 - FLOATING POINT)
12.4 16.36 22.6 16.03

Enter the number of data acquisition loops.  (INTEGER)
22

Enter Delta f as specified by the ADC.  (FLOATING POINT)
0.2

Start the data tape.  Press "CONTINUE".

Do you want:  Coherence blanking (enter 2)
              Pulser Blanking    (enter 0) ?
0

Enter the minimum blanking value. (Floating Point)
0.0037
```


10N
HPOP/LPOP Ratio H(f)
Pulser Blanked
TEST #66 DWELLS 9/25/80
NO ACCUM 22:06:52
1
0
-1
-2
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
10-2 HZ LIN

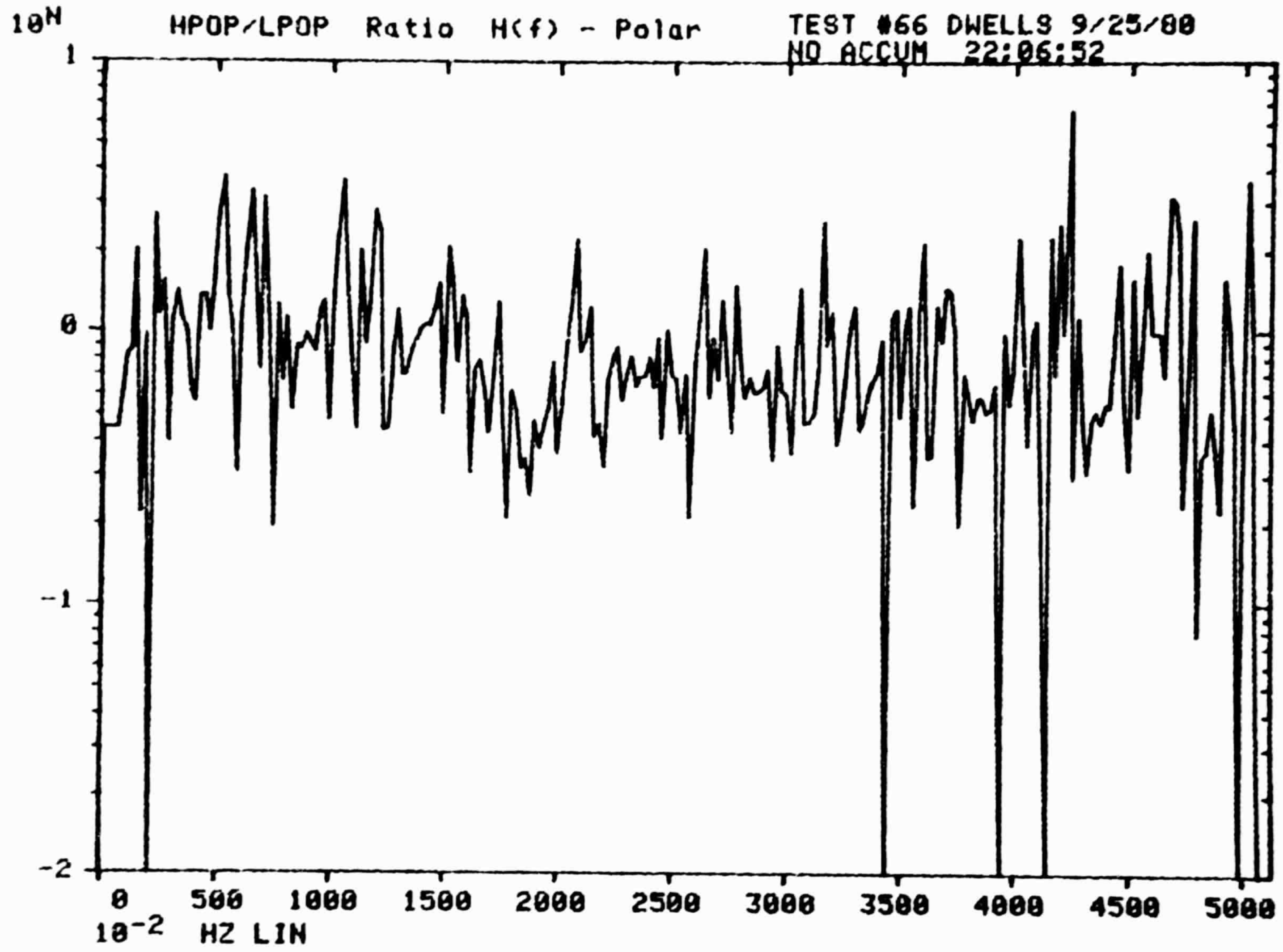


HPOP/LPOP Ratio H(f)
Pulser Blanked
TEST #66 DWELLS 9/25/80
NO ACCUM 22:06:52
10 0
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
.5
.0
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
10⁻² HZ LIN

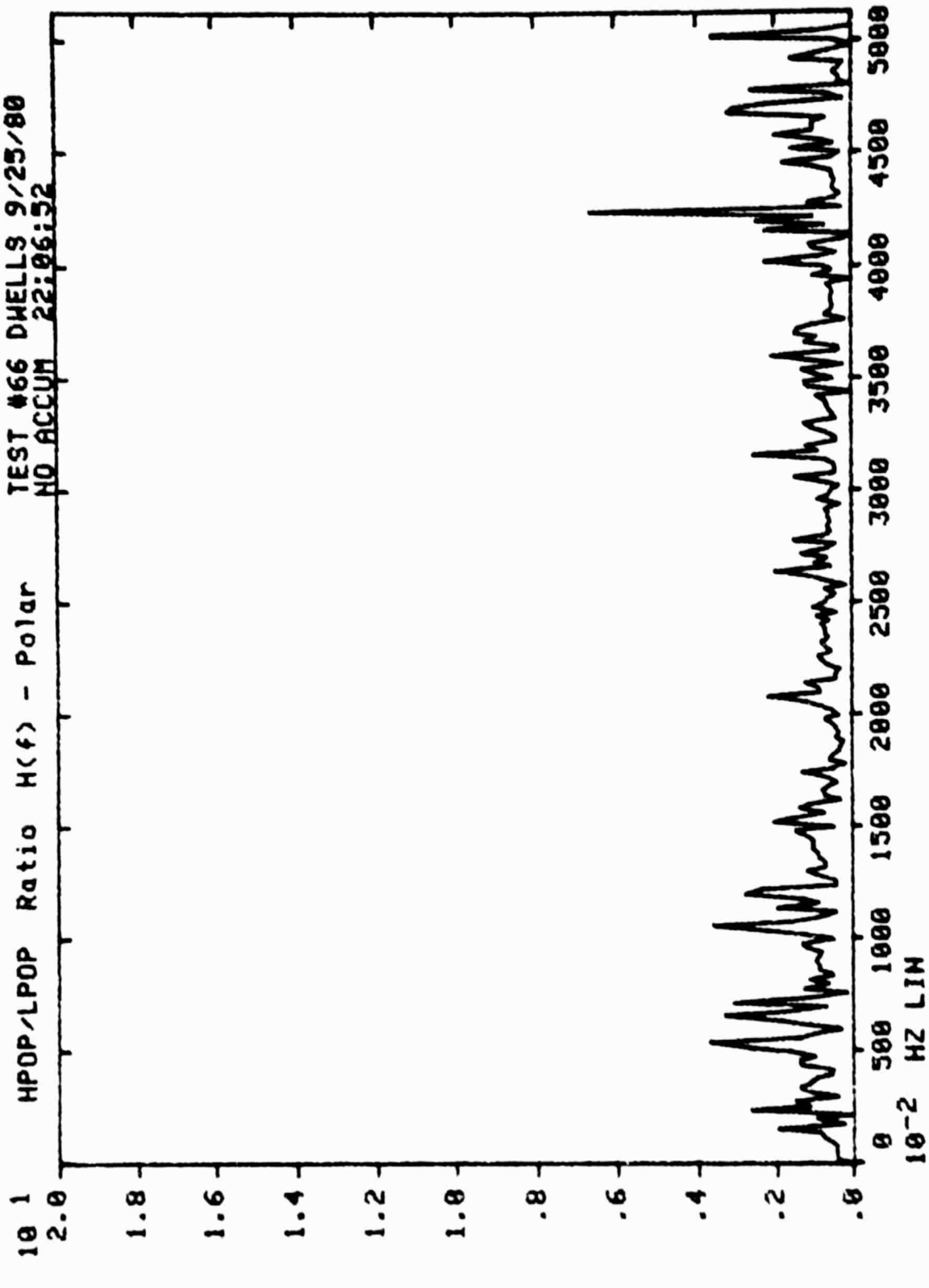
E4

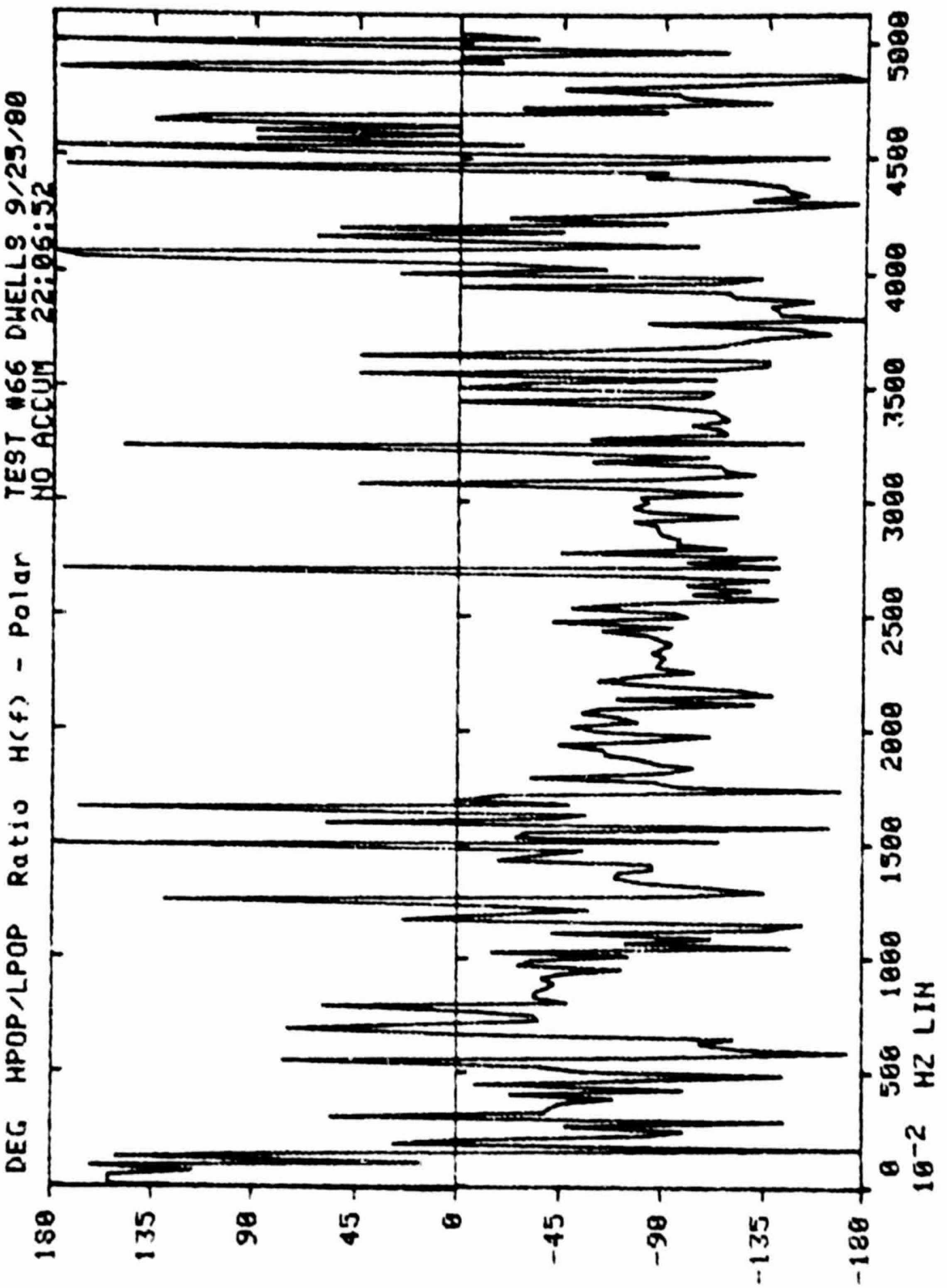


DEGHPOP/LPOP Ratio H(f)
Pulser Blanked
TEST #66 DWELLS 9/25/80
NO ACCUM 22:06:52
180
135
90
45
0
-45
-90
-135
-180
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
10^{-2} HZ LIN

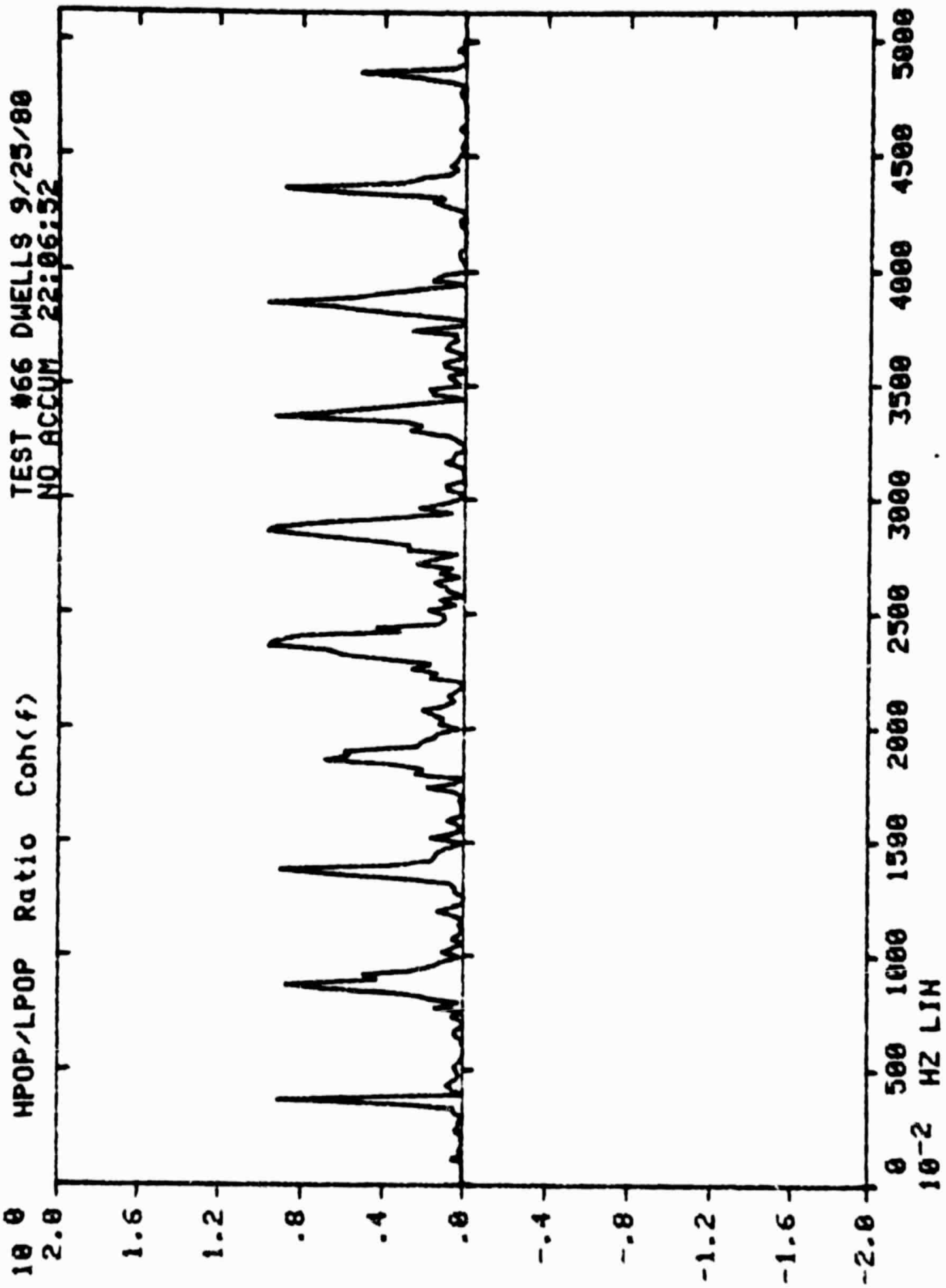

10^N
HPOP/LPOP Ratio H(f) - Polar
TEST #66 DWELLS 9/25/80
NO ACCUM 22:06:52
1
0
-1
-2
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
10^-2 HZ LIN

E6

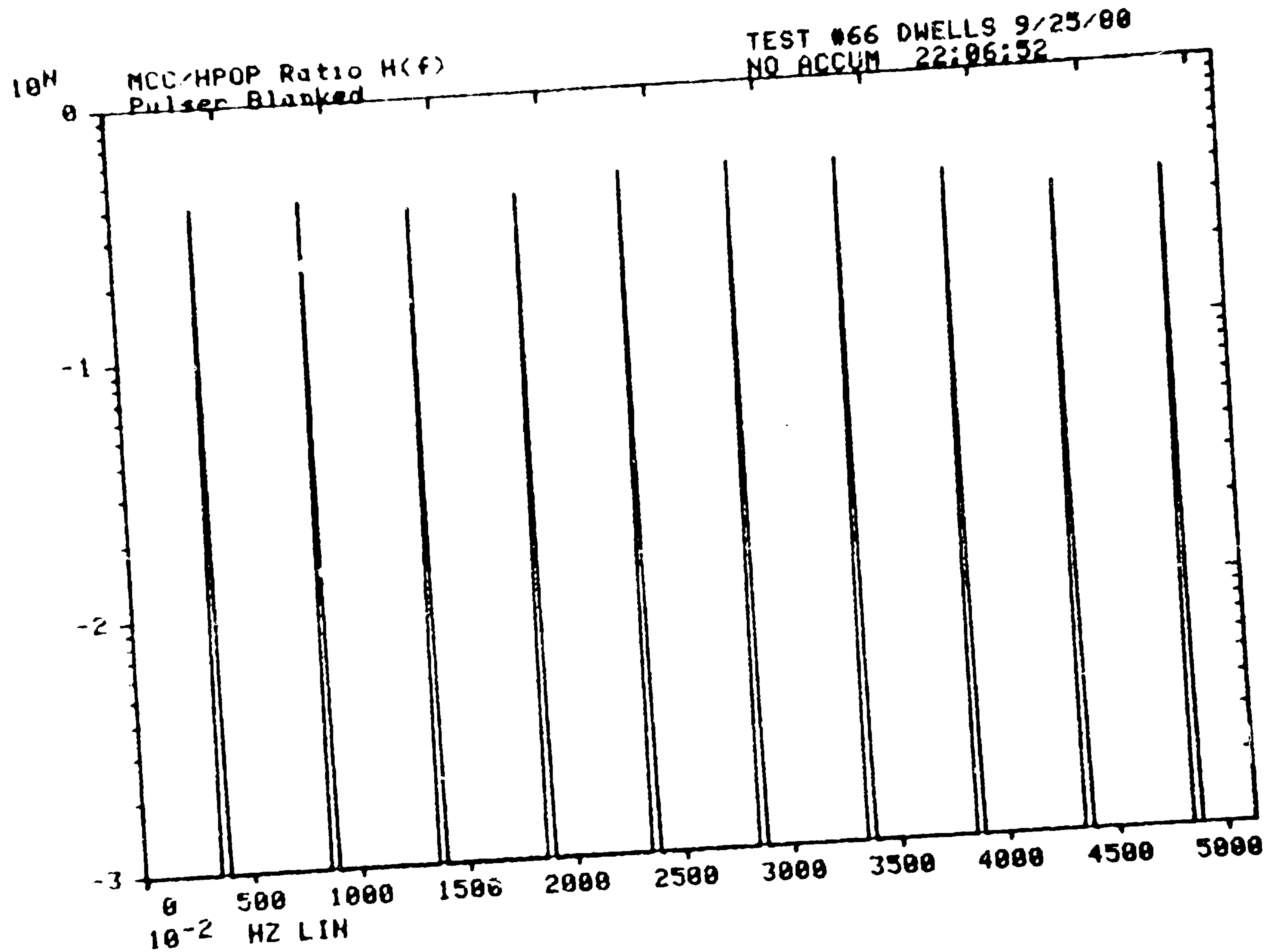

HPOP/LPOP Ratio H(f) - Polar
TEST #66 DWELLS 9/25/80
NO ACCUM 22:06:52
10 1
2.0
1.8
1.6
1.4
1.2
1.0
.8
.6
.4
.2
.0
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
10^-2 HZ LIN

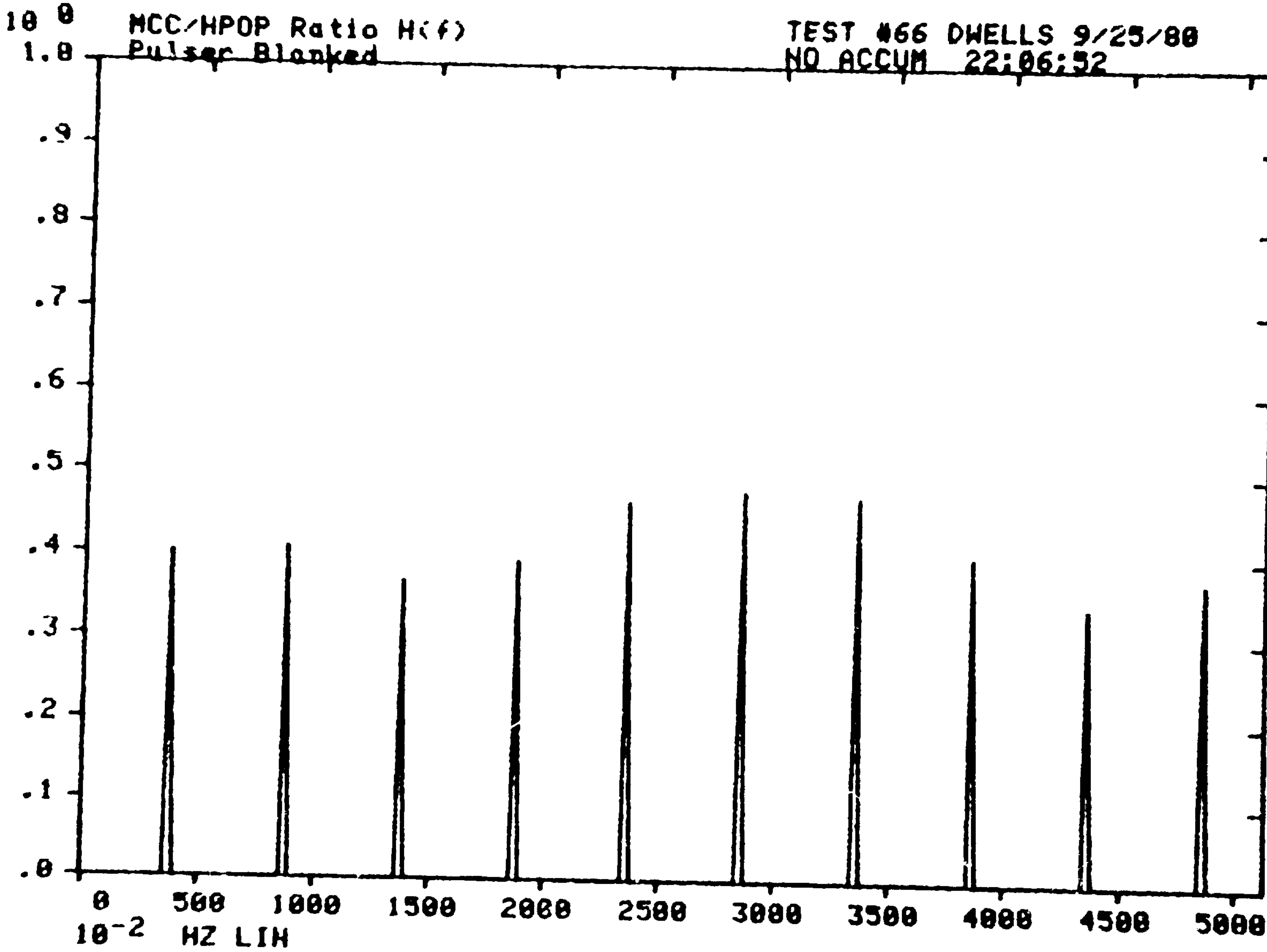

DEG HPOP/LPOP Ratio H(f) - Polar TEST #66 DWELLS 9/25/80
NO ACCUM 22:06:52
180
135
90
45
0
-45
-90
-135
-180
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
10^-2
HZ LIN

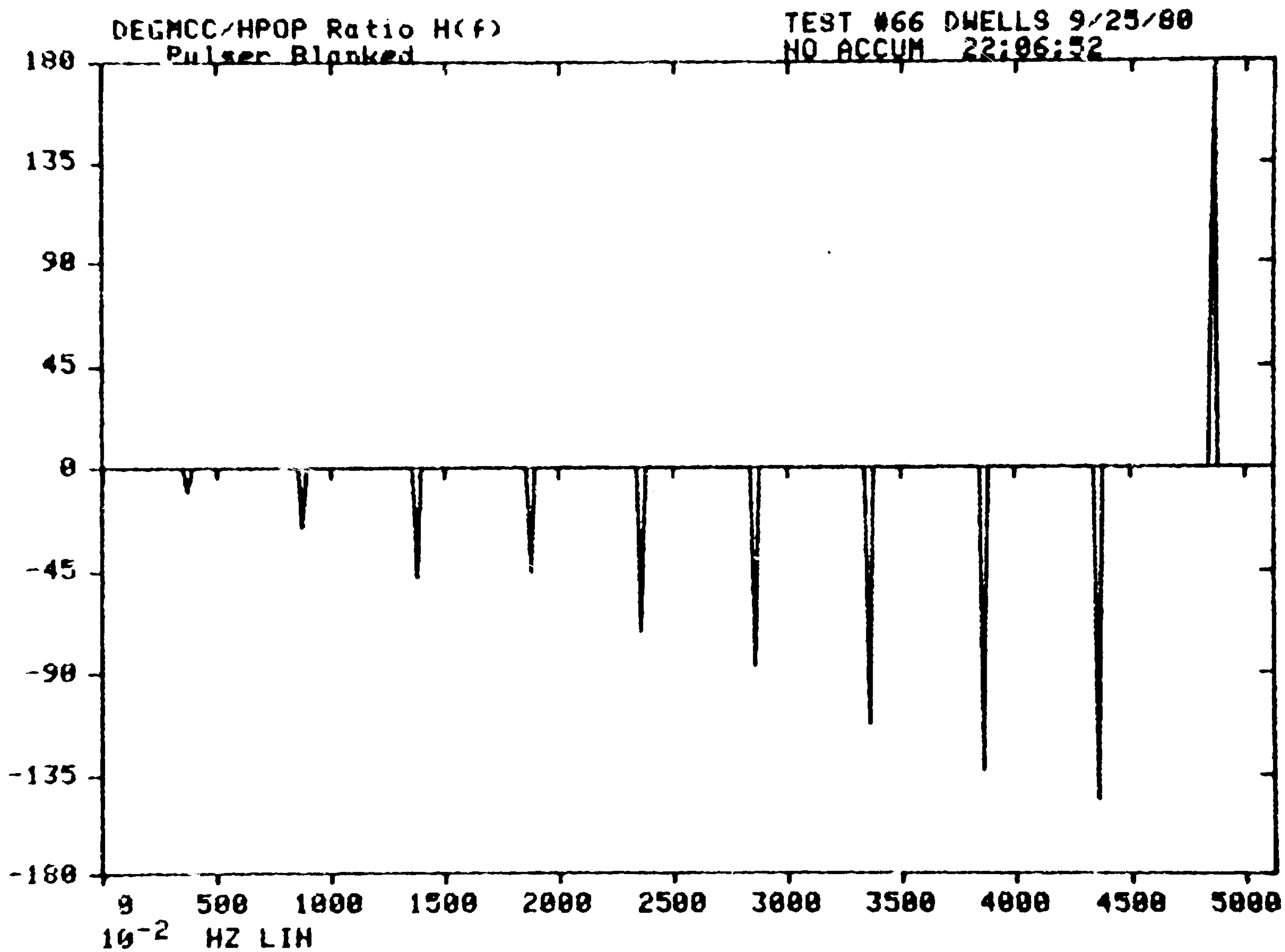
E8



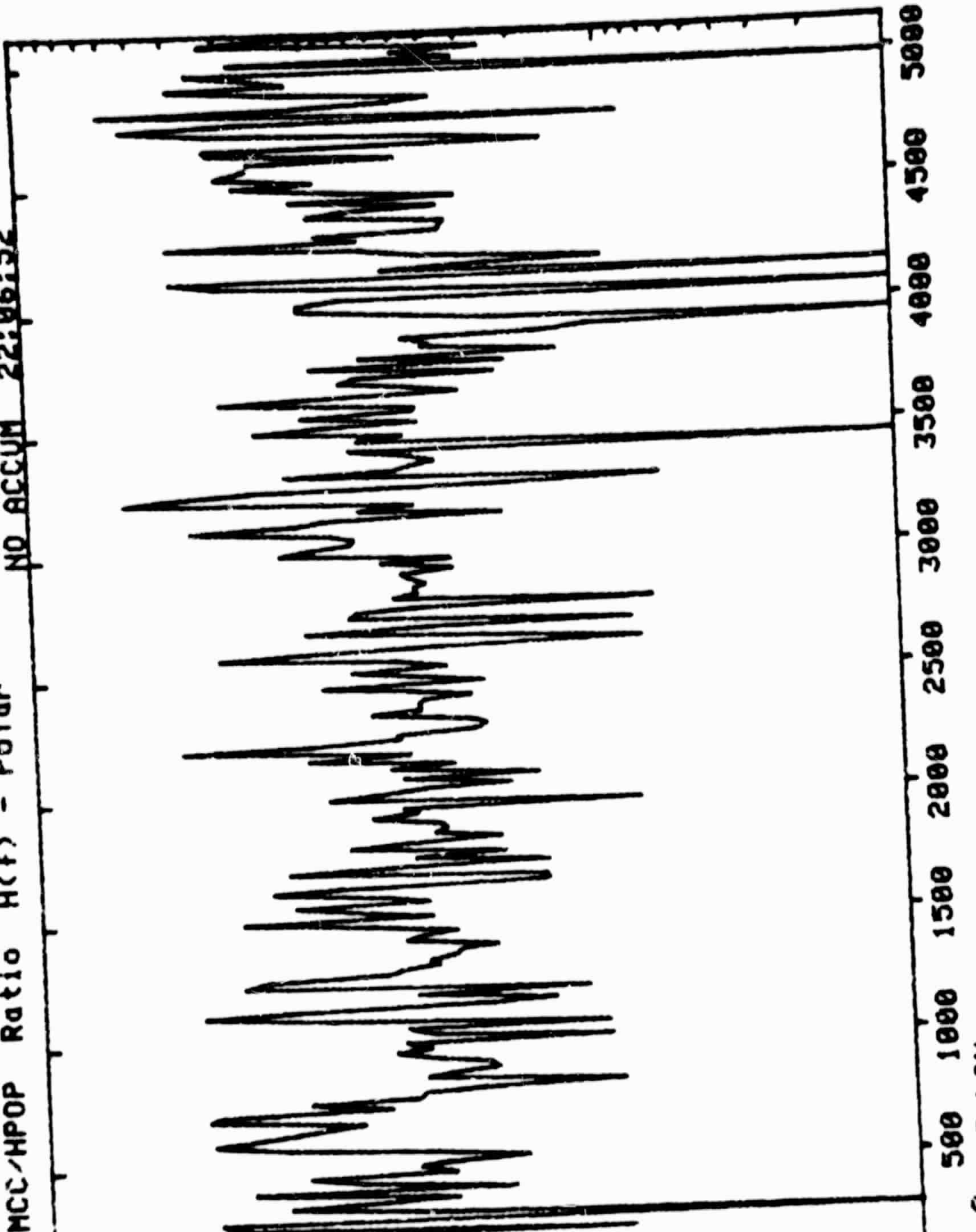
HPOP/LPOP Ratio Coh(f)
TEST #66 DWELLS 9/25/80
NO ACCUM 22:06:52
HZ LIN
10^-2
10 0


TEST #66 DWELLS 9/25/80
NO ACCUM 22:06:52
MCC/HPOP Ratio H(f)
Pulser Blanked
10N
0
-1
-2
-3
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
10-2 HZ LIN


10 0
MCC/HPOP Ratio H(f)
Pulser Blanked
TEST #66 DWELLS 9/25/80
NO ACCUM 22:06:52
1.0
.9
.8
.7
.6
.5
.4
.3
.2
.1
.0
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
10-2 HZ LIN

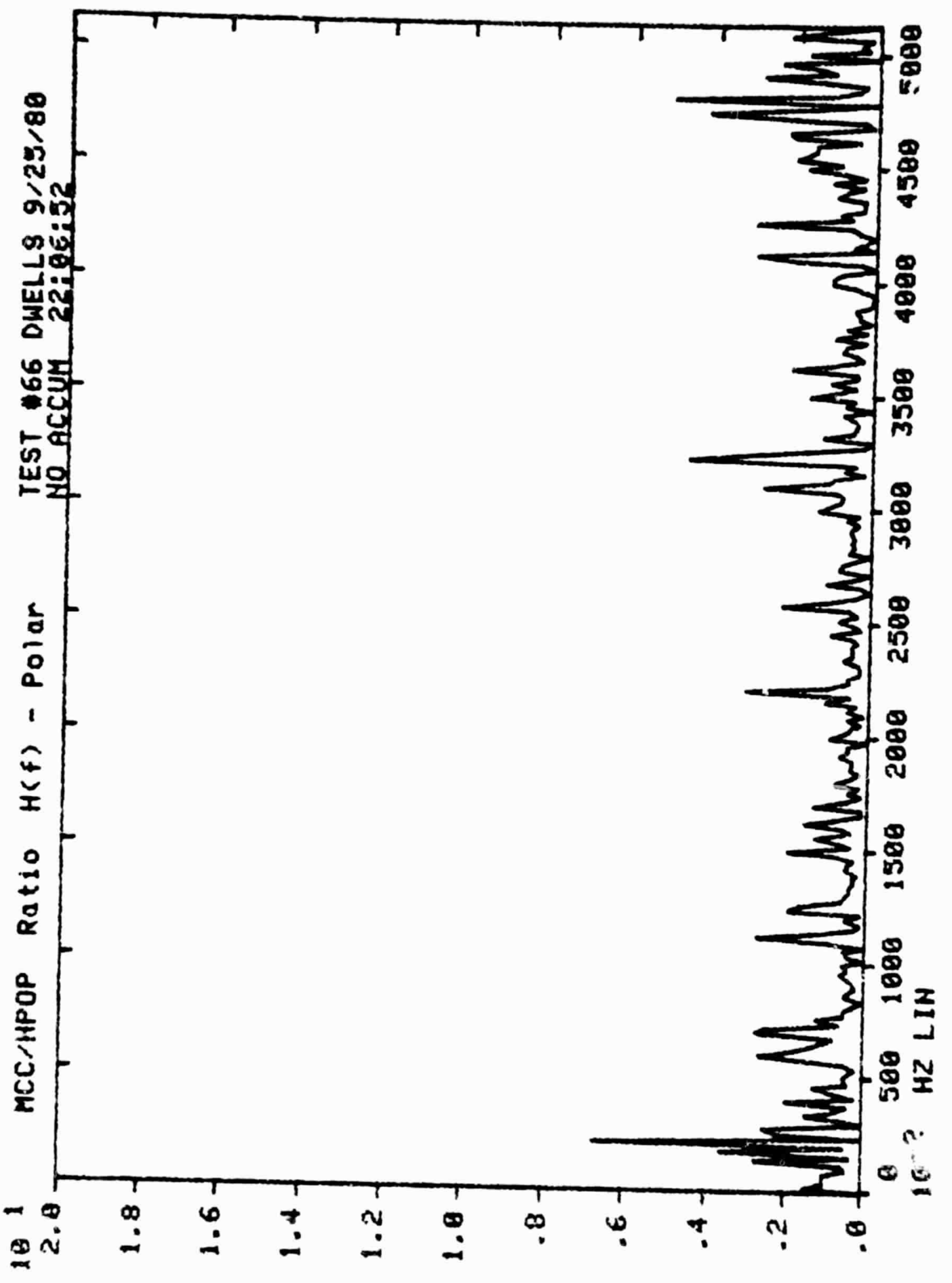

DEGMCC/HPOP Ratio H(f)
Pulser Blanked
TEST #66 DWELLS 9/25/80
NO ACCUM 22:06:52
180
135
90
45
0
-45
-90
-135
-180
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
10^{-2} HZ LIN

E12



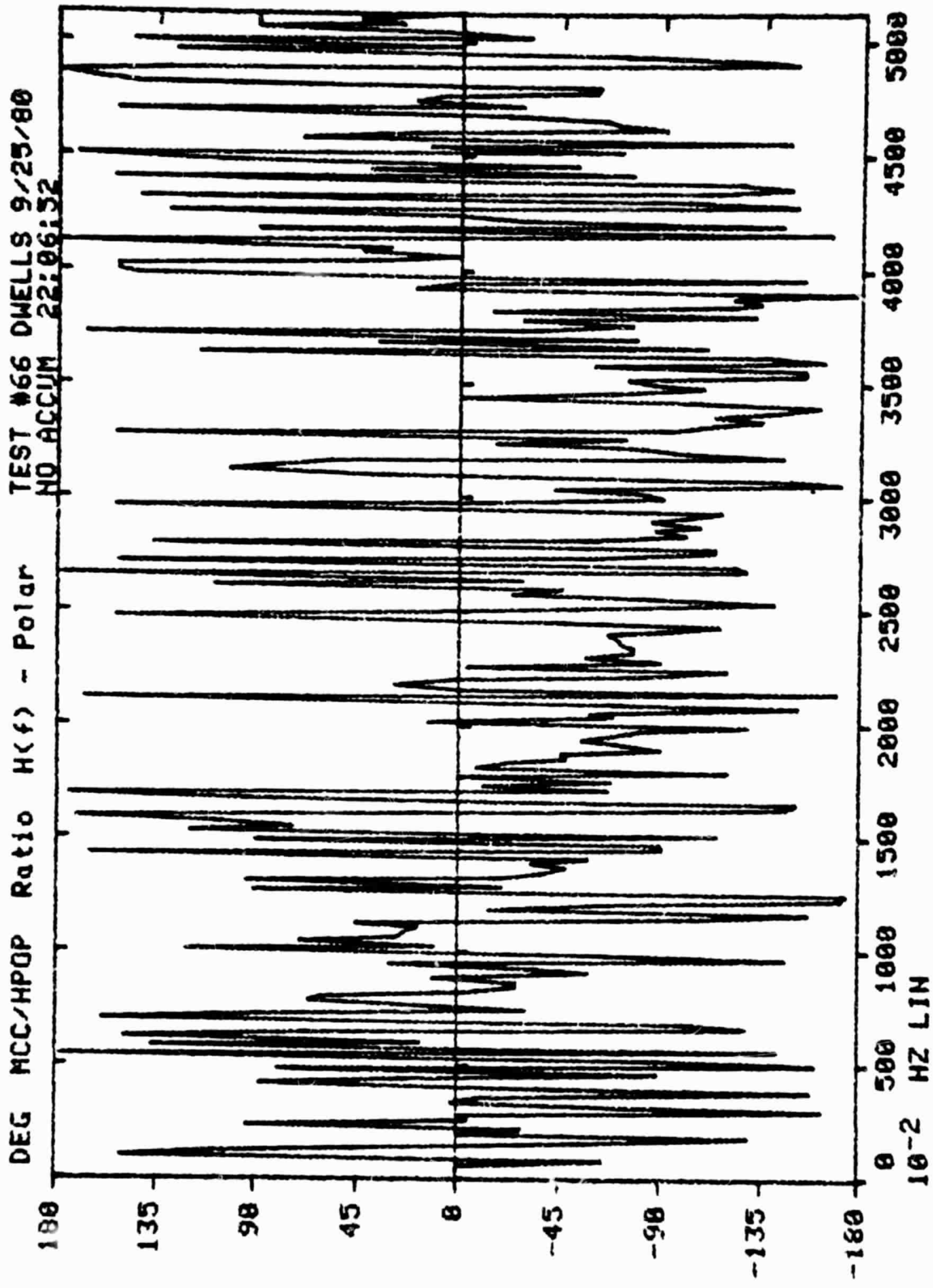
MCC/HPOP Ratio H(f) - Polar
TEST #66 DWELLS 9/25/80
NO ACCUM 22:06:52
10N
1
0
-1
-2
0
10-2
500
HZ LIN
1000
1500
2000
2500
3000
3500
4000
4500
5000

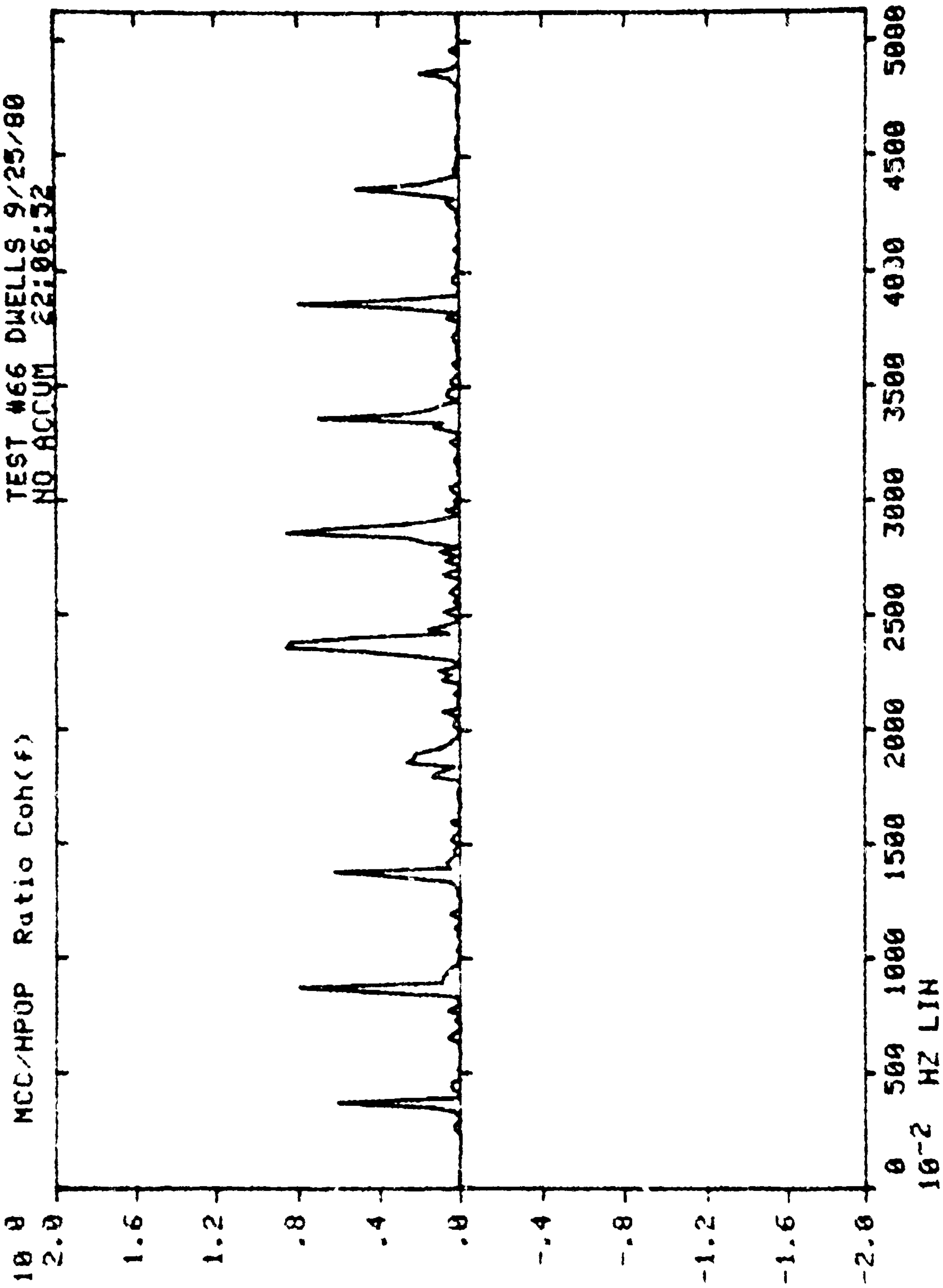
E13



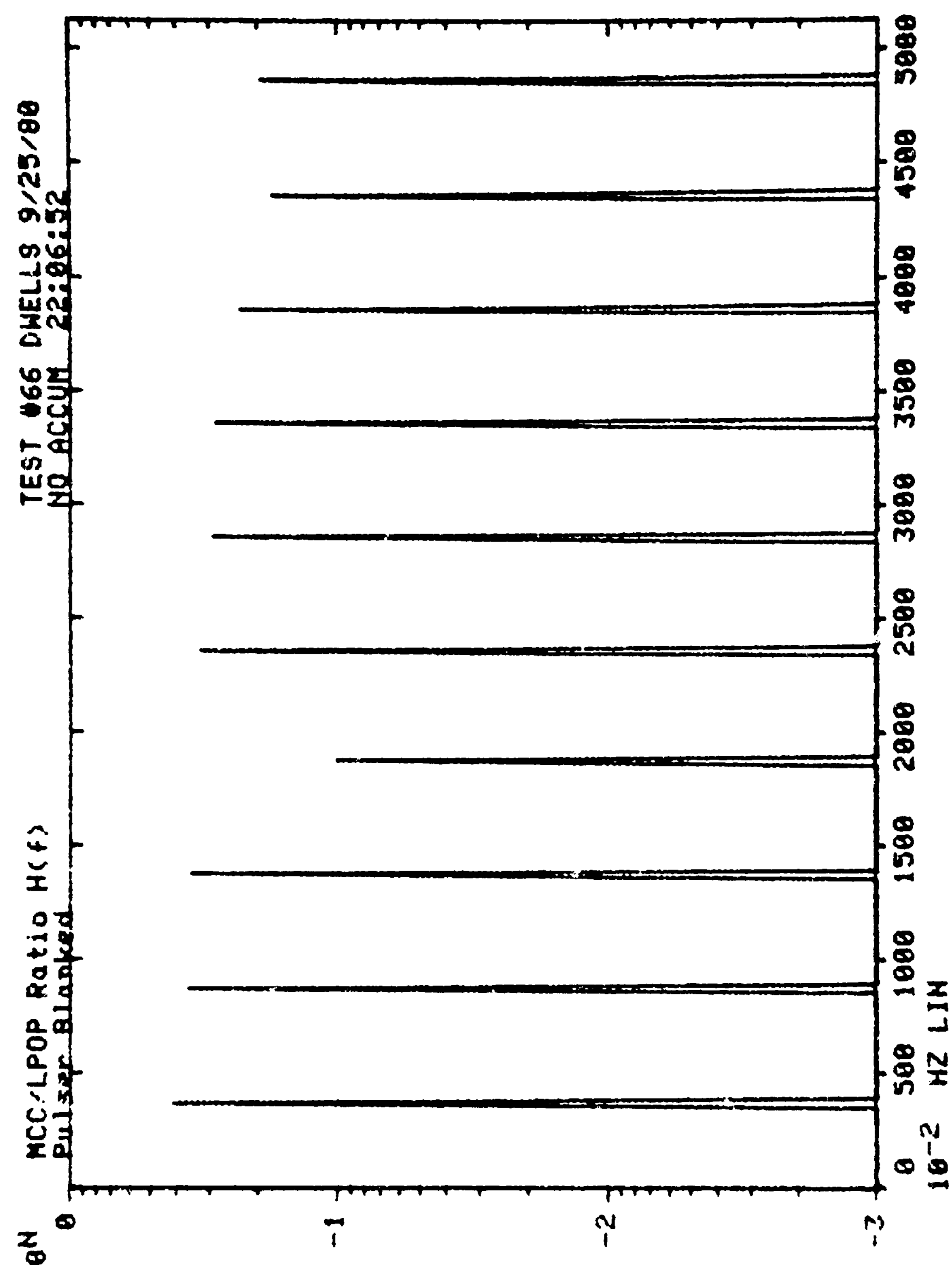
MCC/HPOP Ratio H(f) - Polar
TEST #66 DWELLS 9/23/80
NO ACCUM 22:06:52
10 1
2.0
1.8
1.6
1.4
1.2
1.0
.8
.6
.4
.2
.0
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
HZ LIN

E14

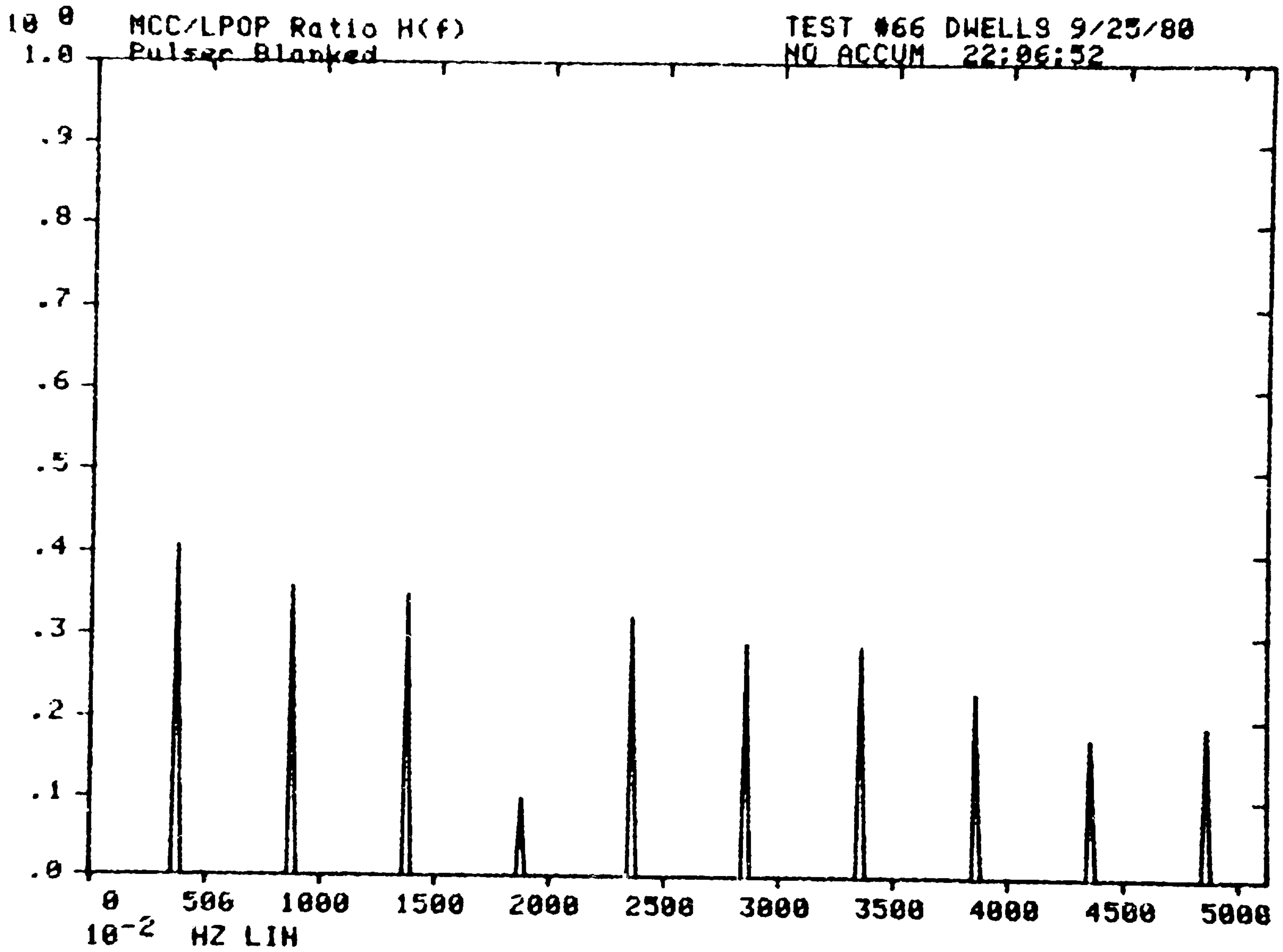

DEG MCC/HPOP Ratio H(f) - Polar
TEST #66 DWELLS 9/25/80
NO ACCUM 22:06:32
180
135
90
45
0
-45
-90
-135
-180
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
10^-2 HZ LIN


MCC/HPOP Ratio Coh(f)
TEST #66 DWELLS 9/25/80
NO ACCUM 22:06:52
10 0
2.0
1.6
1.2
.8
.4
.0
-.4
-.8
-1.2
-1.6
-2.0
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
10^-2 HZ LIN

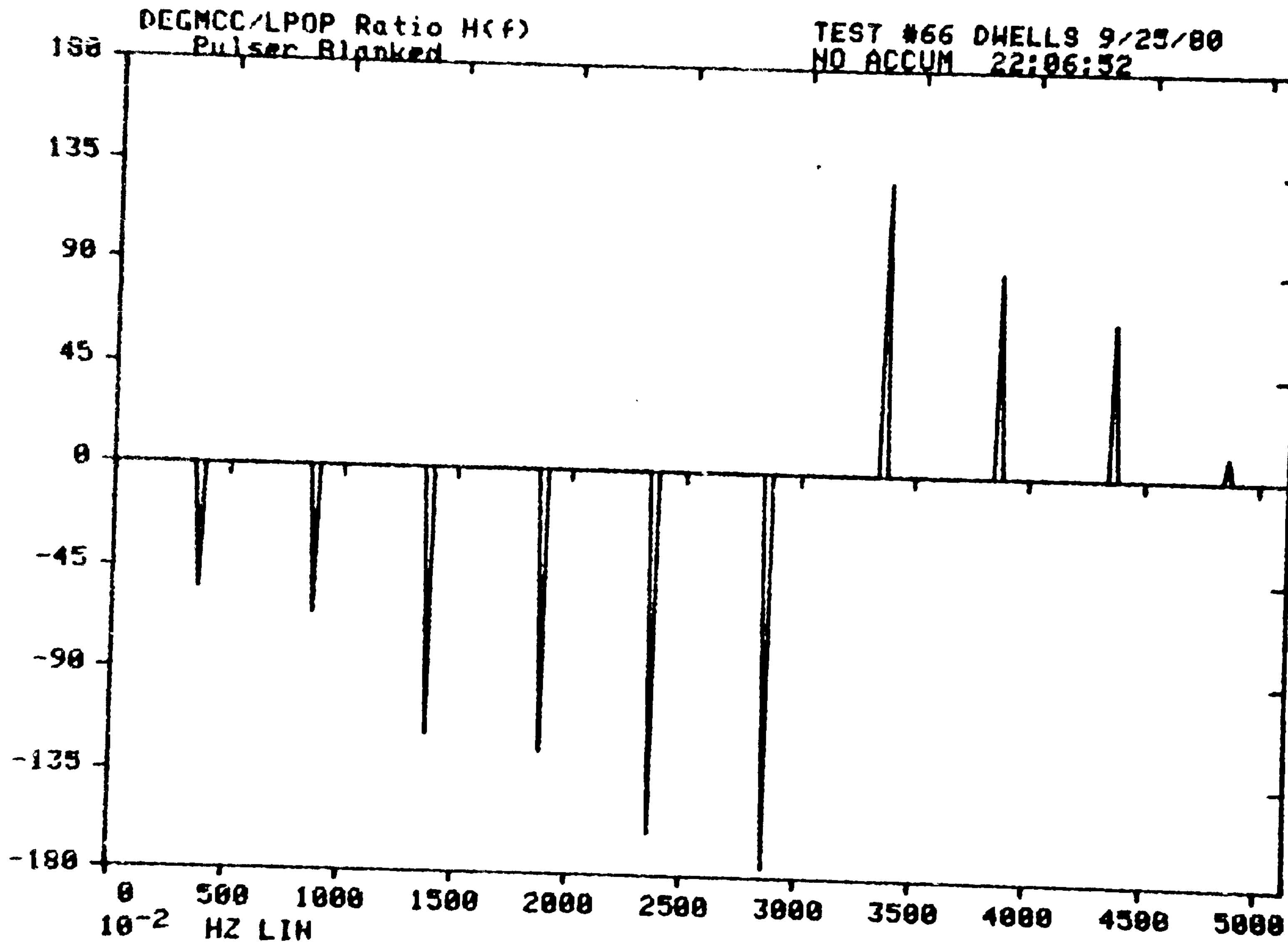
E16



MCC/LPOP Ratio H(f)
Pulser Blanked
TEST #66 DWELLS 9/25/80
NO ACCUM 22:06:52
10N
0
-1
-2
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
10^-2 HZ LIN

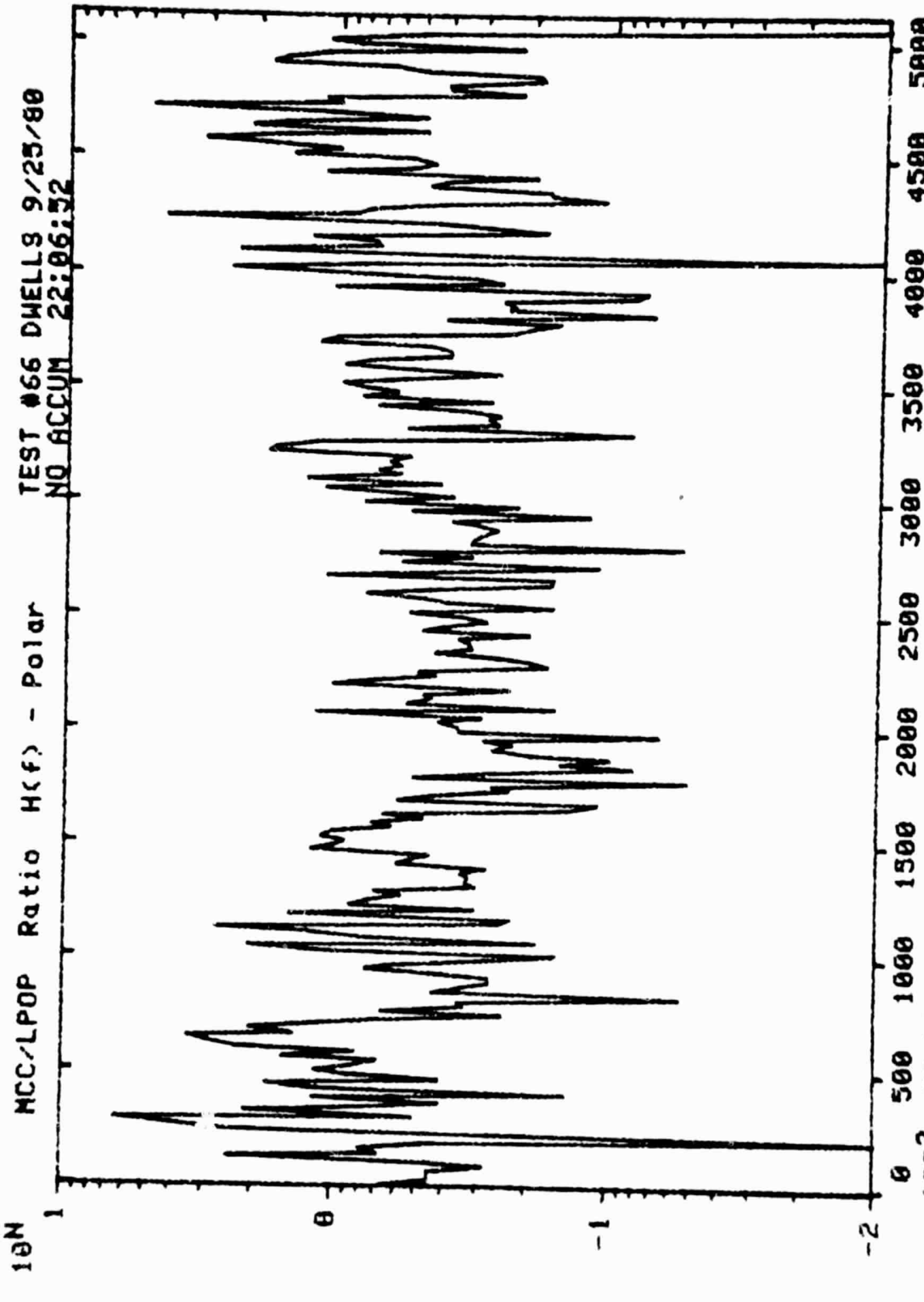

10 0
MCC/LPOP Ratio H(f)
Pulser Blanked
TEST #66 DWELLS 9/25/80
NO ACCUM 22:06:52
1.0
.9
.8
.7
.6
.5
.4
.3
.2
.1
.0
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
10-2 HZ LIN

E17

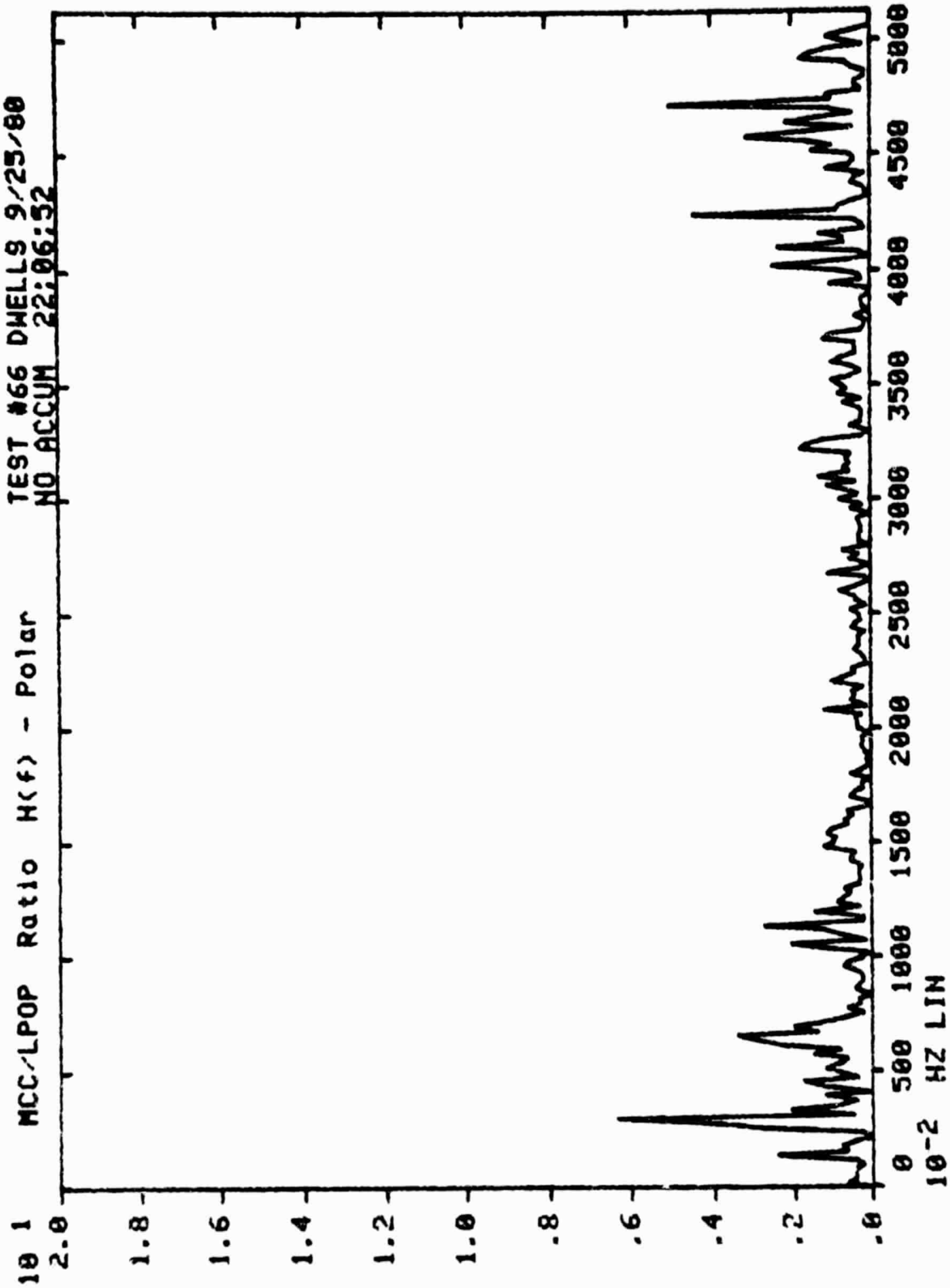


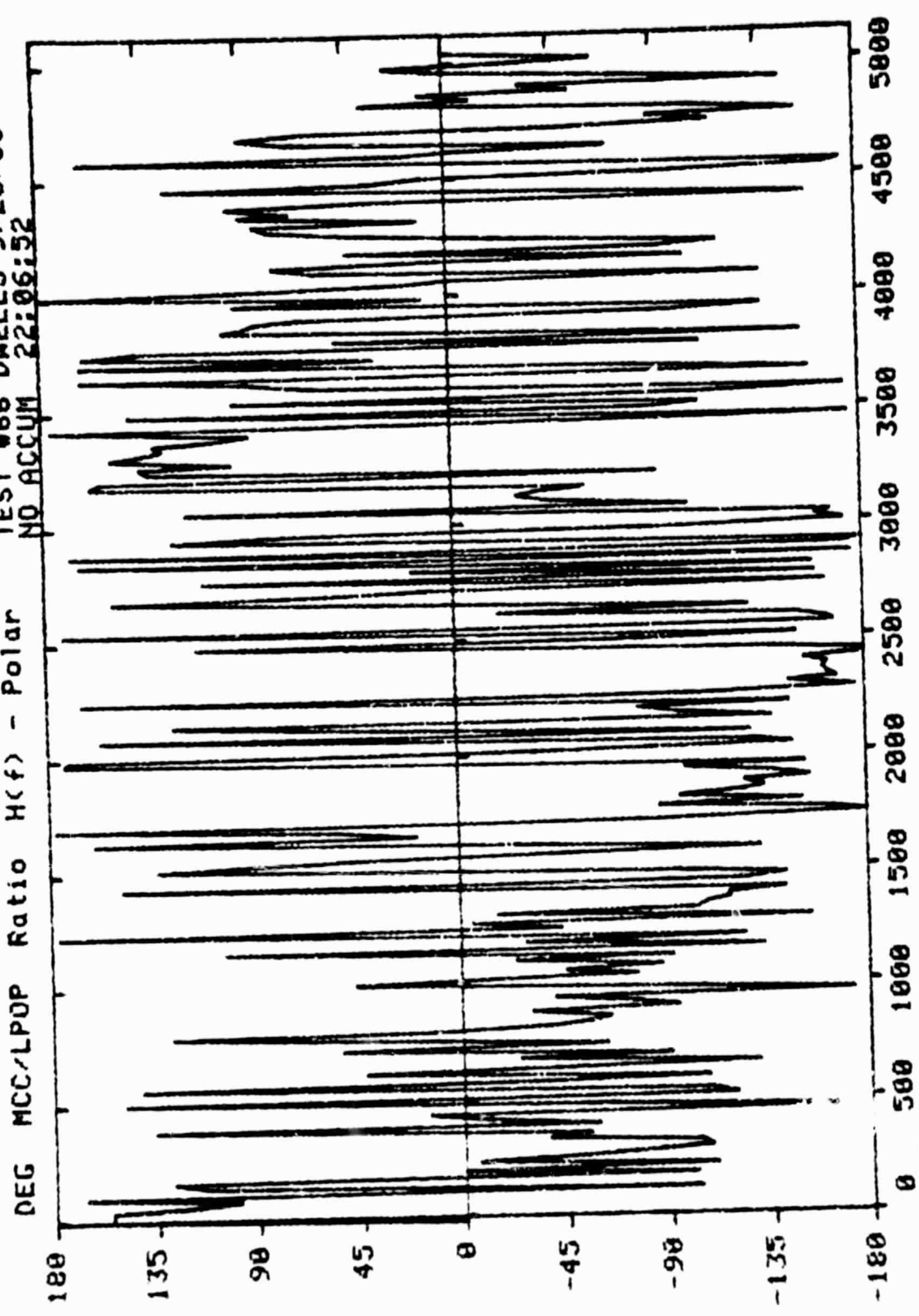
DEGMCC/LPOP Ratio H(f)
Pulser Blanked
TEST #66 DWELLS 9/25/80
NO ACCUM 22:06:52
180
135
90
45
0
-45
-90
-135
-180
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
10^-2 HZ LIN

E19

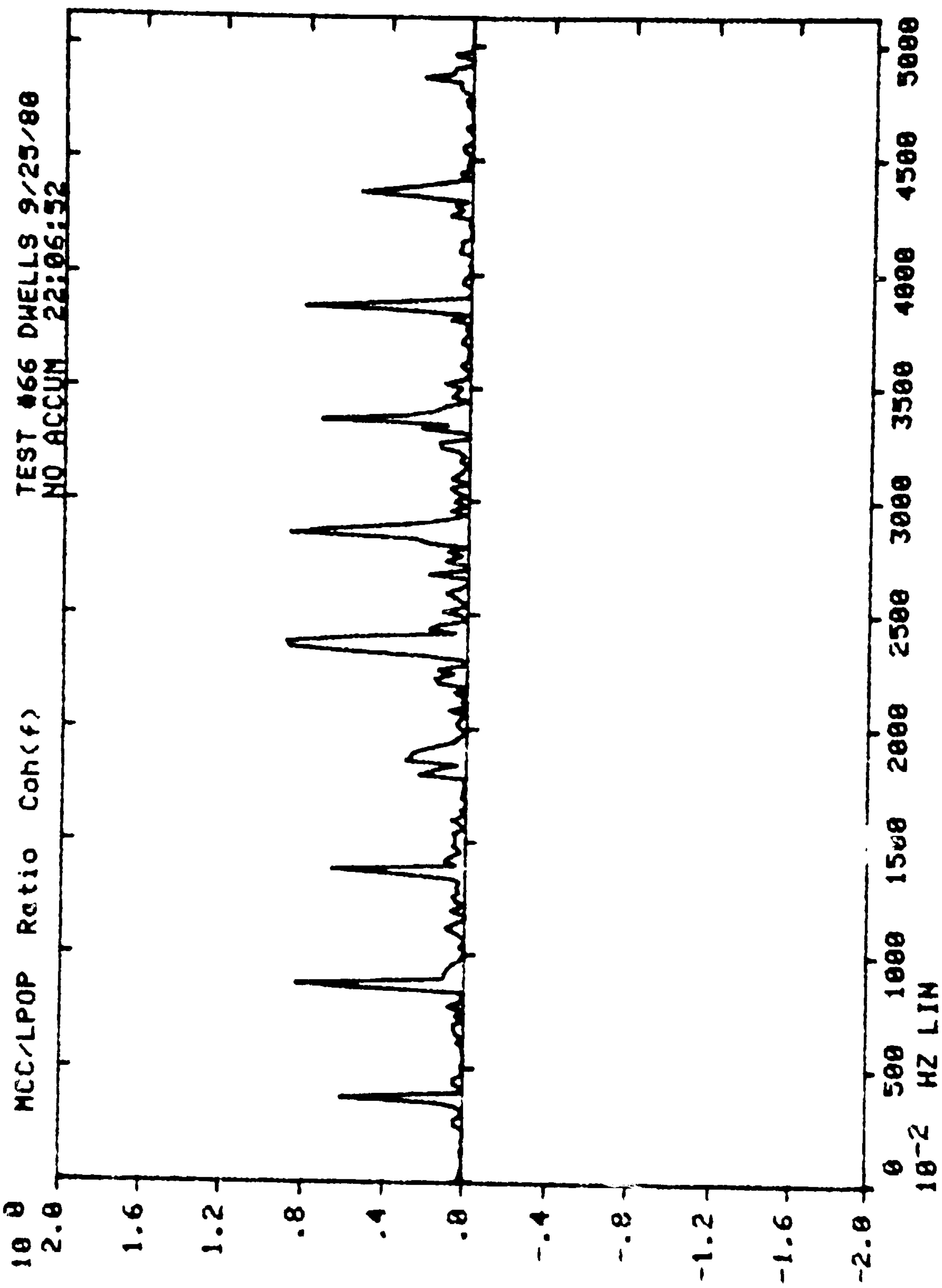

MCC/LPOP Ratio H(f) - Polar
TEST #66 DWELLS 9/25/80
NO ACCUM 22:06:32
10N
1
0
-1
-2
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
10^-2 HZ LIN

E20

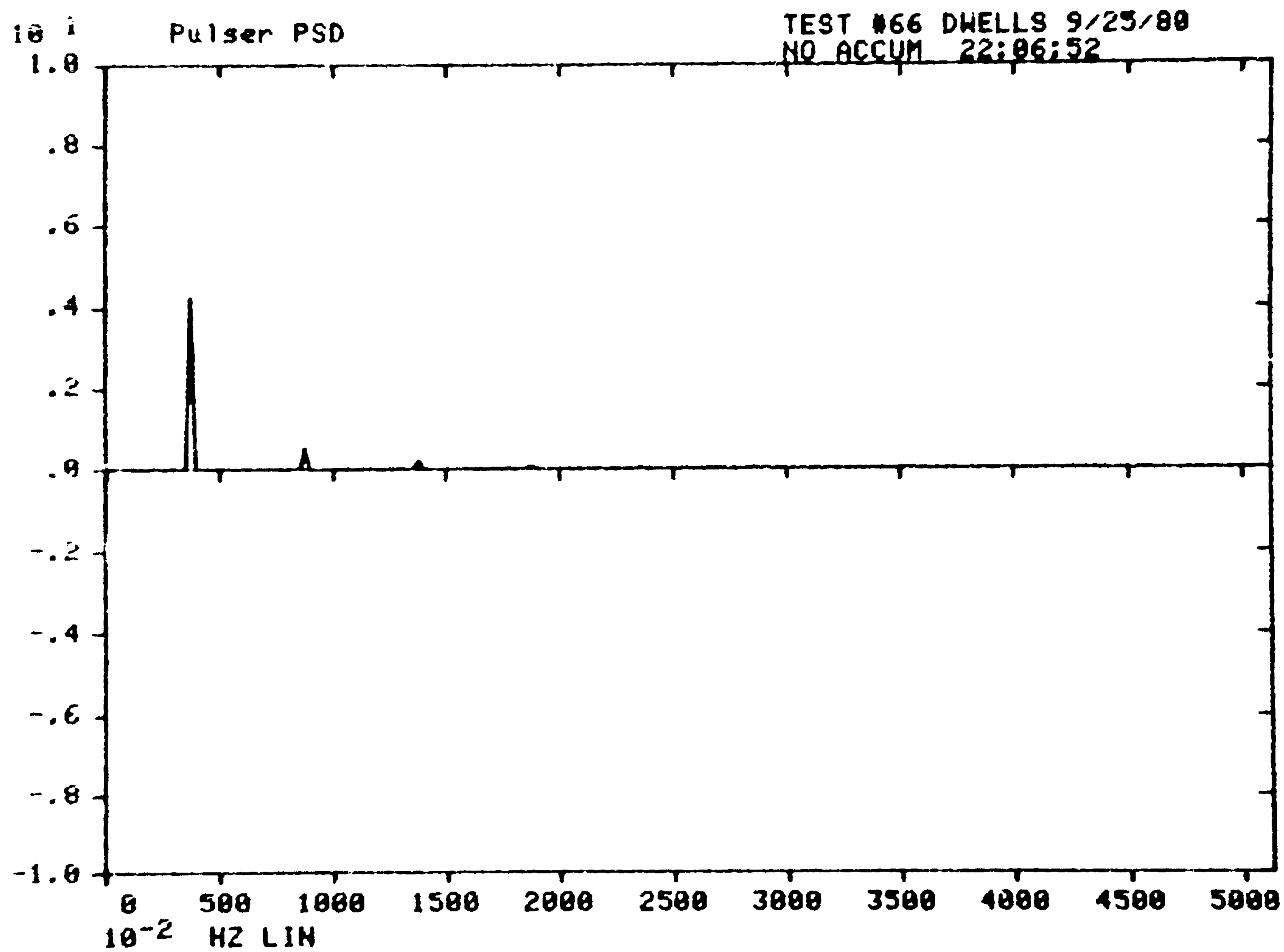

MCC/LPOP Ratio H(f) - Polar
TEST #66 DWELLS 9/25/80
NO ACCUM 22:06:52
10 1
2.0
1.8
1.6
1.4
1.2
1.0
.8
.6
.4
.2
.0
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
10-2 HZ LIN


DEG MCC/LPOP Ratio H(f) - Polar
TEST #66 DWELLS 9/25/80
NO ACCUM 22:06:52
180
135
90
45
0
-45
-90
-135
-180
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
10^-2 HZ LIN

E22



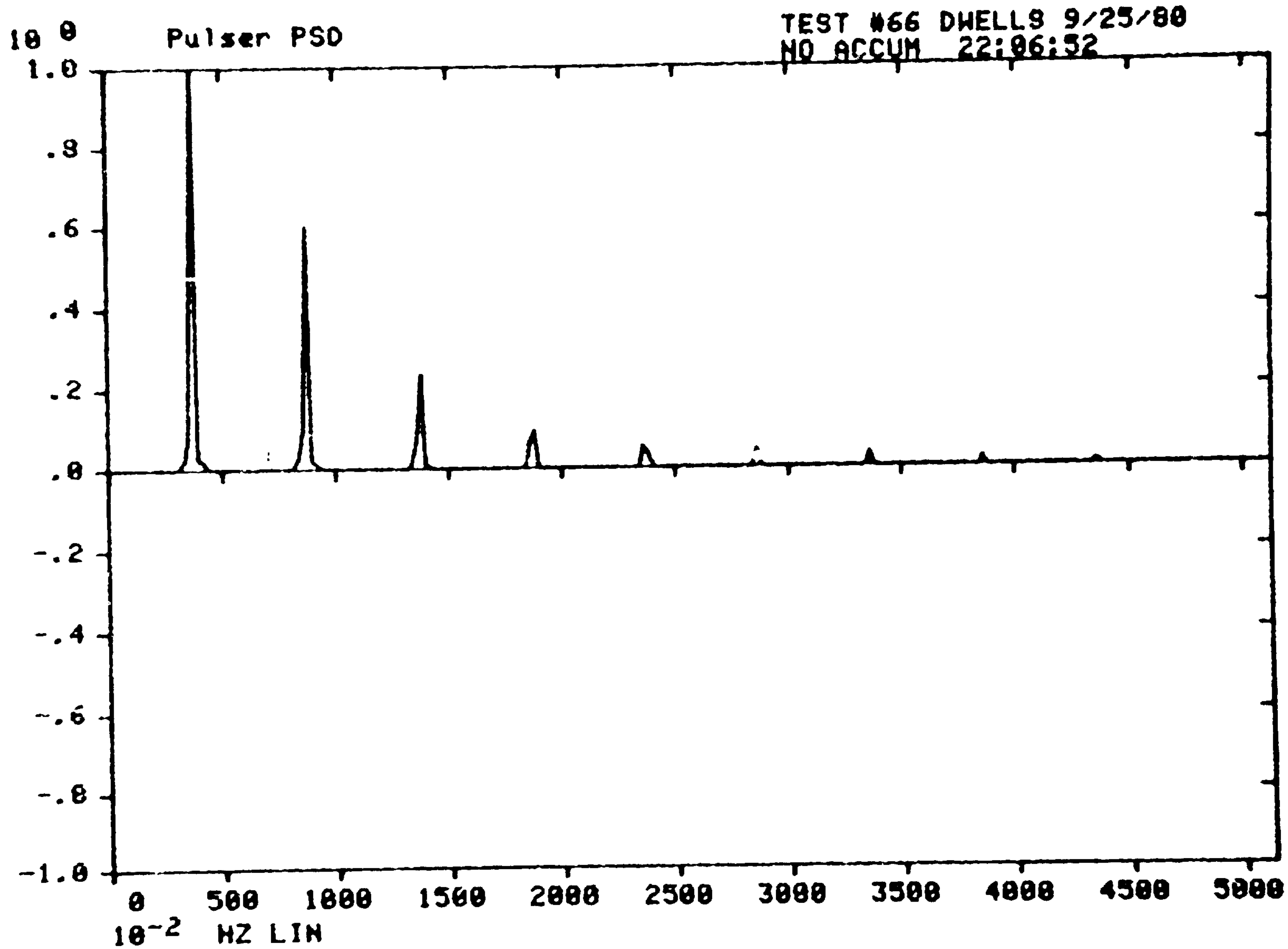
MCC/LPOP Ratio Coh(f)
TEST #66 DWELLS 9/25/80
NO ACCUM 22:06:52
10 0
2.0
1.6
1.2
.8
.4
.0
-.4
-.8
-1.2
-1.6
-2.0
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
10^-2 HZ LIN

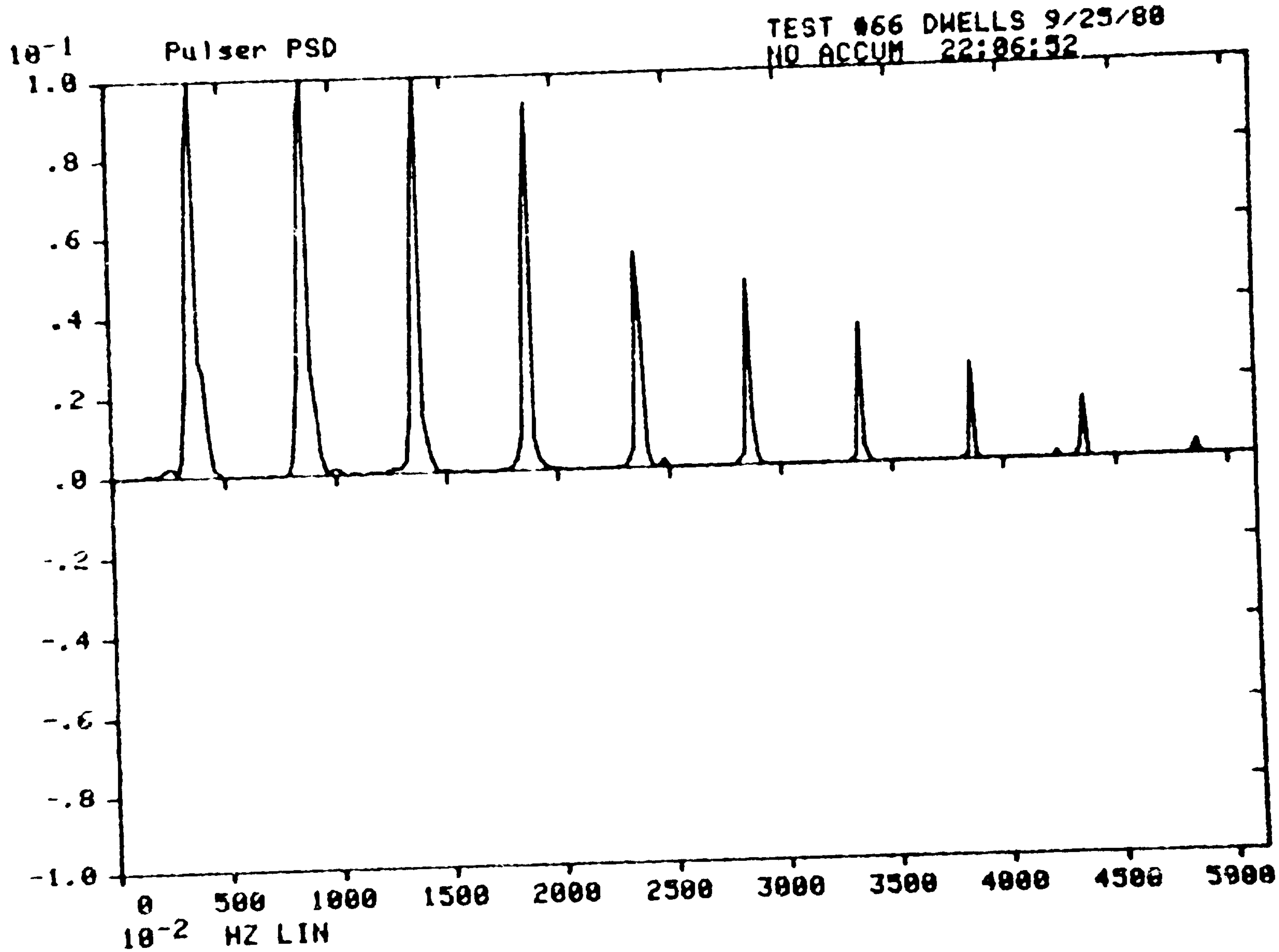


10 1
Pulser PSD
TEST #66 DWELLS 9/25/80
NO ACCUM 22:06:52
1.0
.8
.6
.4
.2
.0
-.2
-.4
-.6
-.8
-1.0
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
10-2 HZ LIN

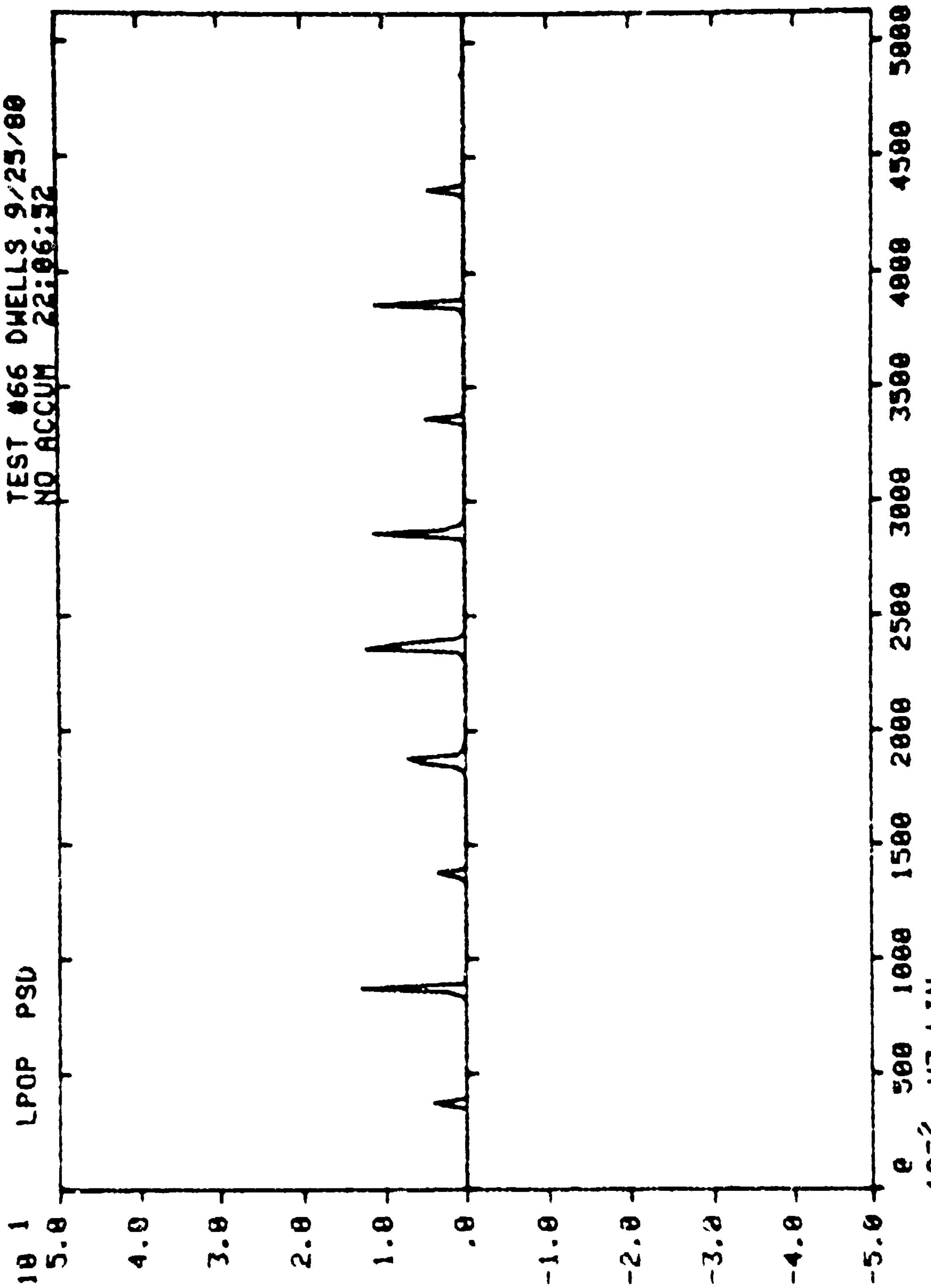
E23

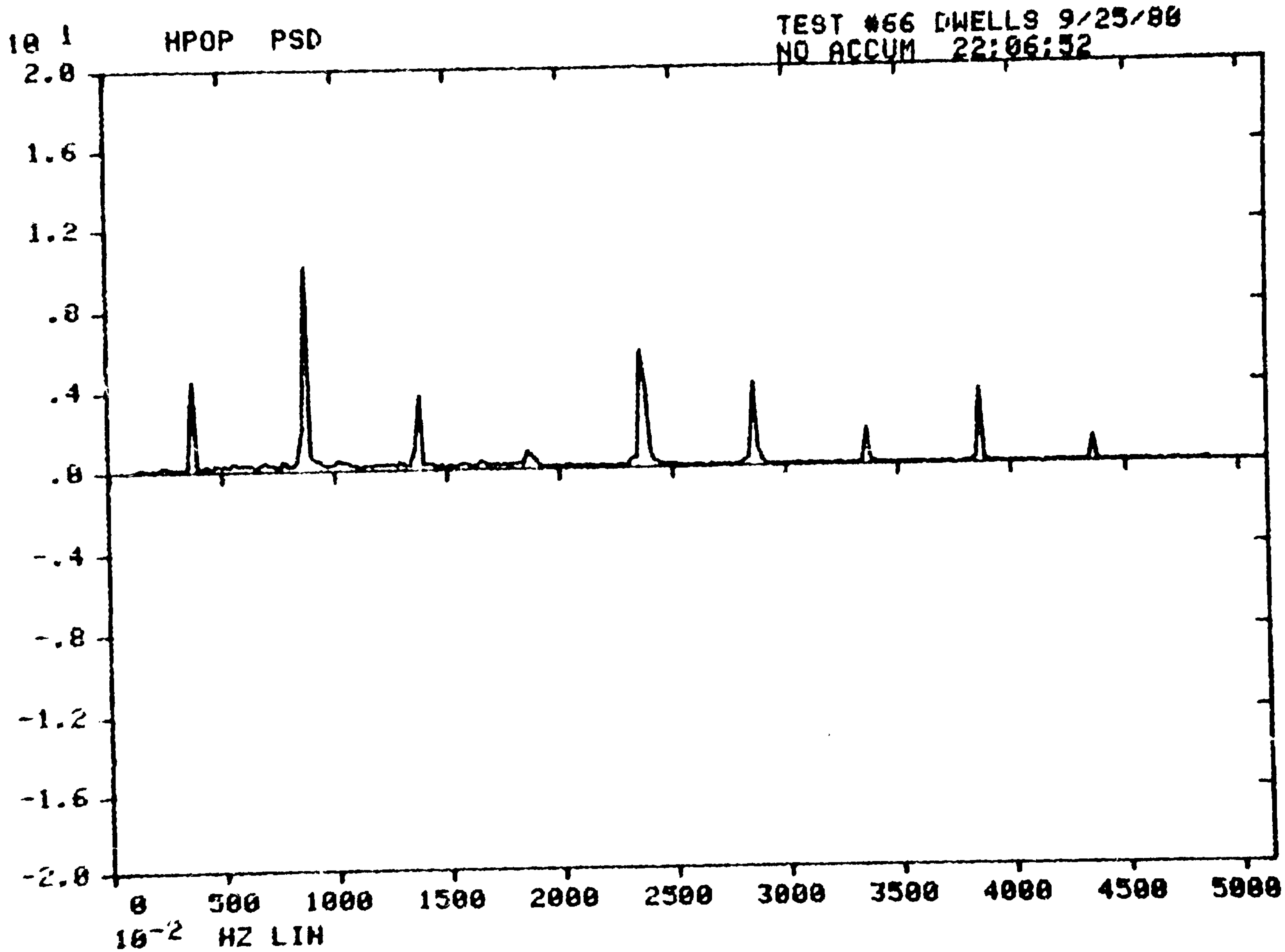
E24


10 0
Pulser PSD
TEST #66 DWELLS 9/25/80
NO ACCUM 22:06:52
1.0
.8
.6
.4
.2
.0
-.2
-.4
-.6
-.8
-1.0
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
10-2 HZ LIN

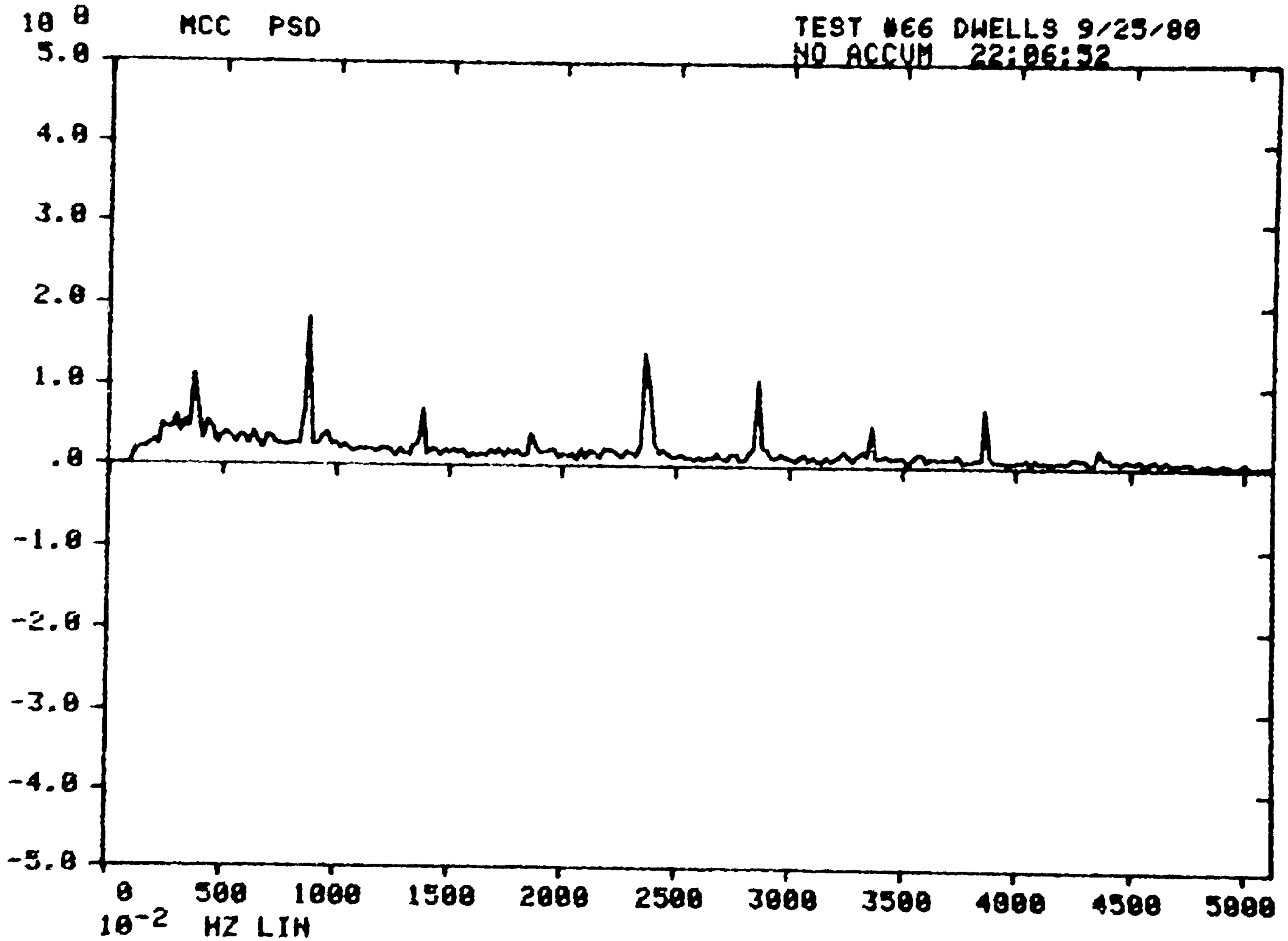


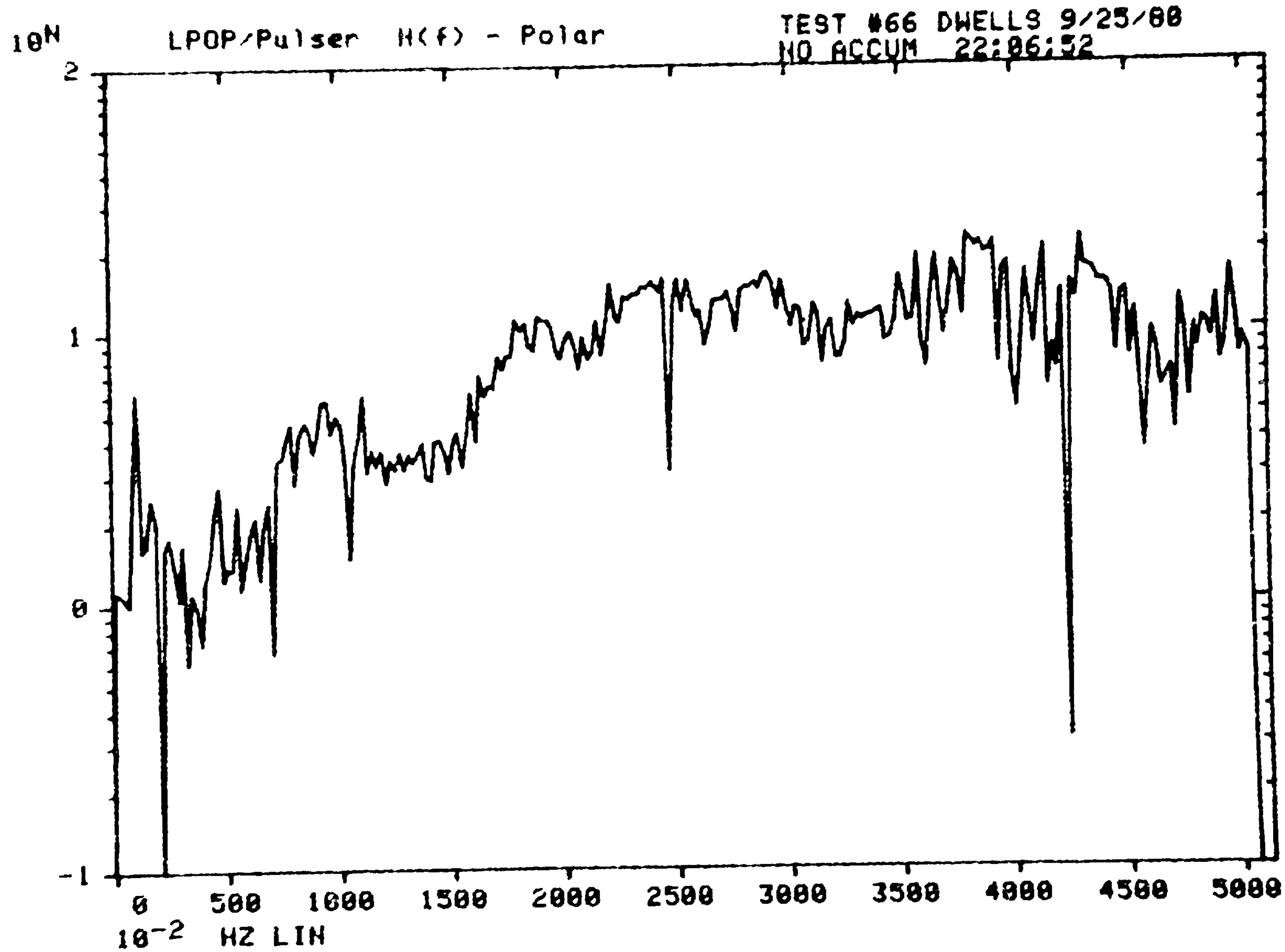
TEST #66 DWELLS 9/25/80
NO ACCUM 22:06:52
Pulser PSD
10^-1
1.0
.8
.6
.4
.2
.0
-.2
-.4
-.6
-.8
-1.0
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
10^-2 HZ LIN


LPOP PSD
TEST #66 DWELLS 9/25/80
NO ACCUM 22:06:52
10 1
5.0
4.0
3.0
2.0
1.0
.0
-1.0
-2.0
-3.0
-4.0
-5.0
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
10^-2 HZ LIN

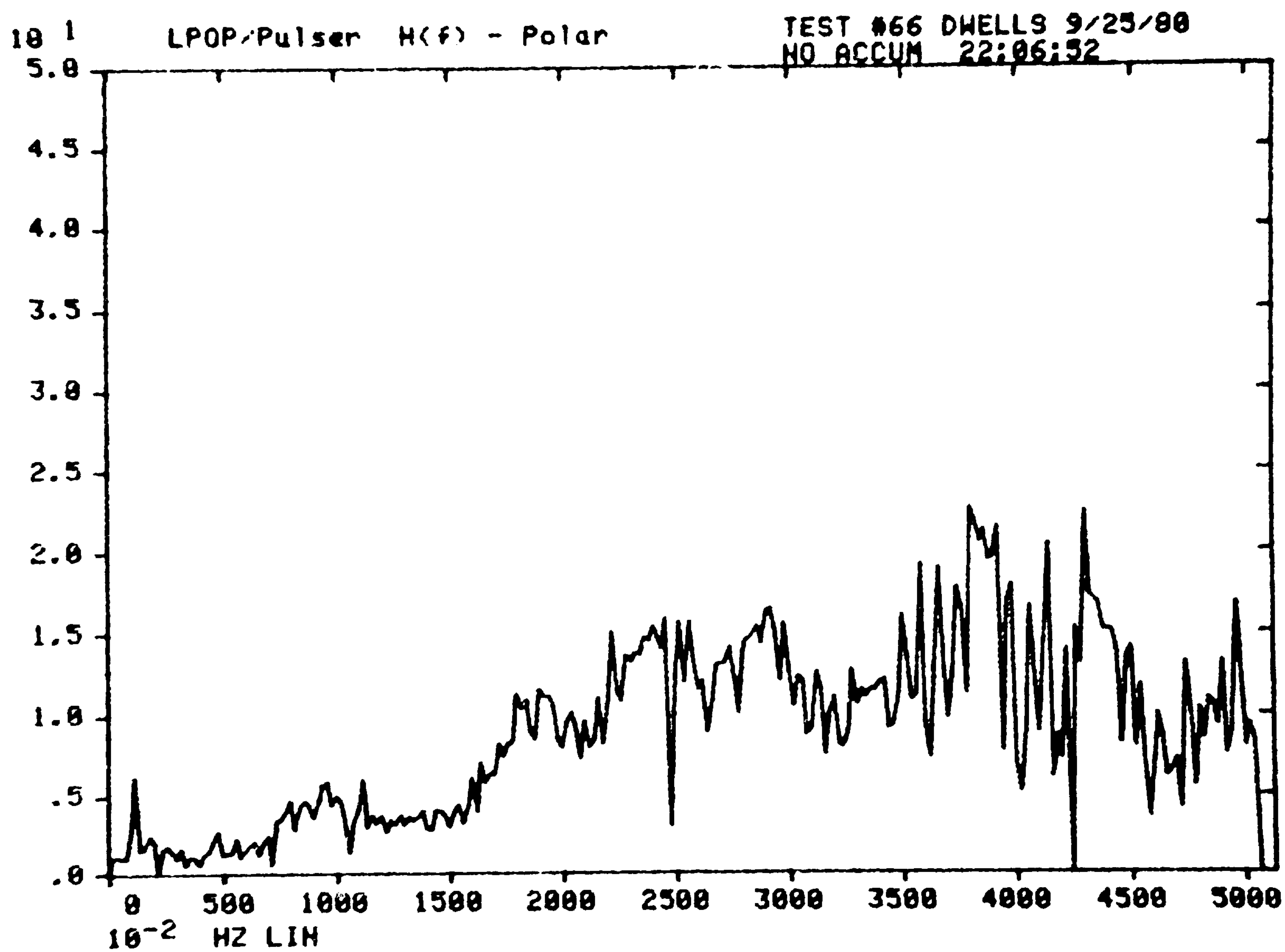


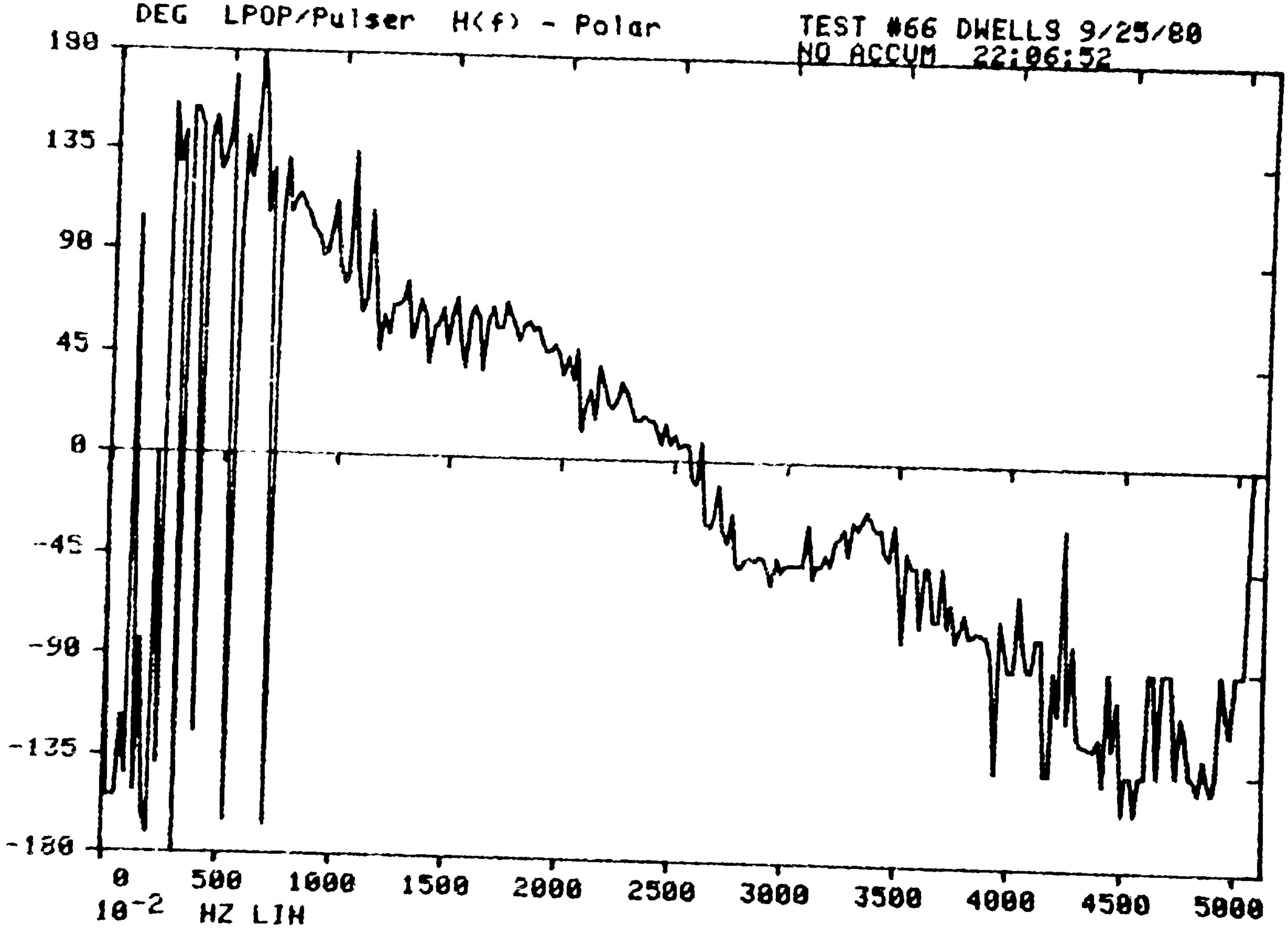
HPOP PSD
TEST #66 DWELLS 9/25/80
NO ACCUM 22:06:52
10 1
2.0
1.6
1.2
.8
.4
.0
-.4
-.8
-1.2
-1.6
-2.0
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
10-2 HZ LIN

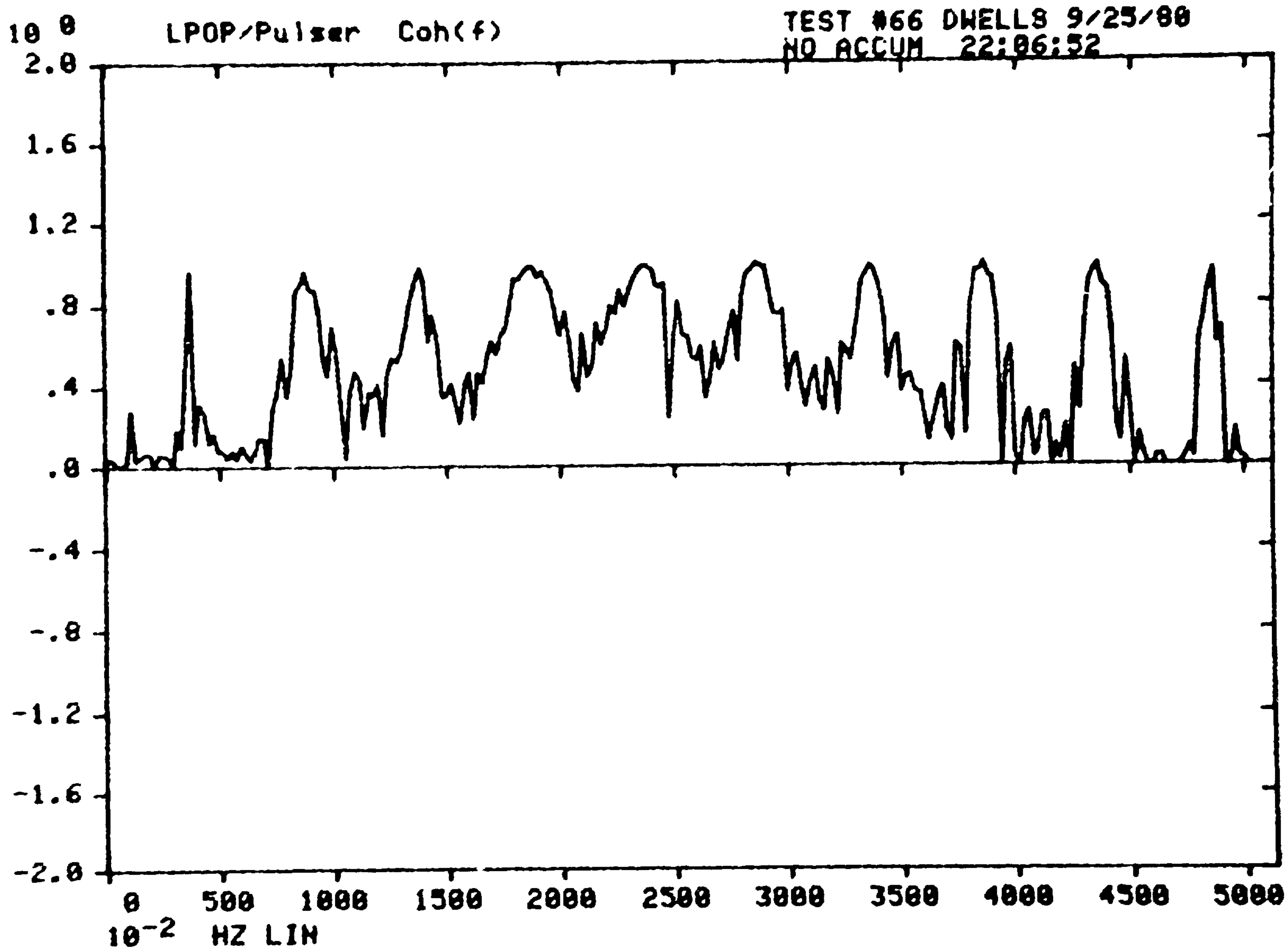

MCC PSD
TEST #66 DWELLS 9/25/80
NO ACCUM 22:06:52
10 0
5.0
4.0
3.0
2.0
1.0
.0
-1.0
-2.0
-3.0
-4.0
-5.0
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
10-2 HZ LIN

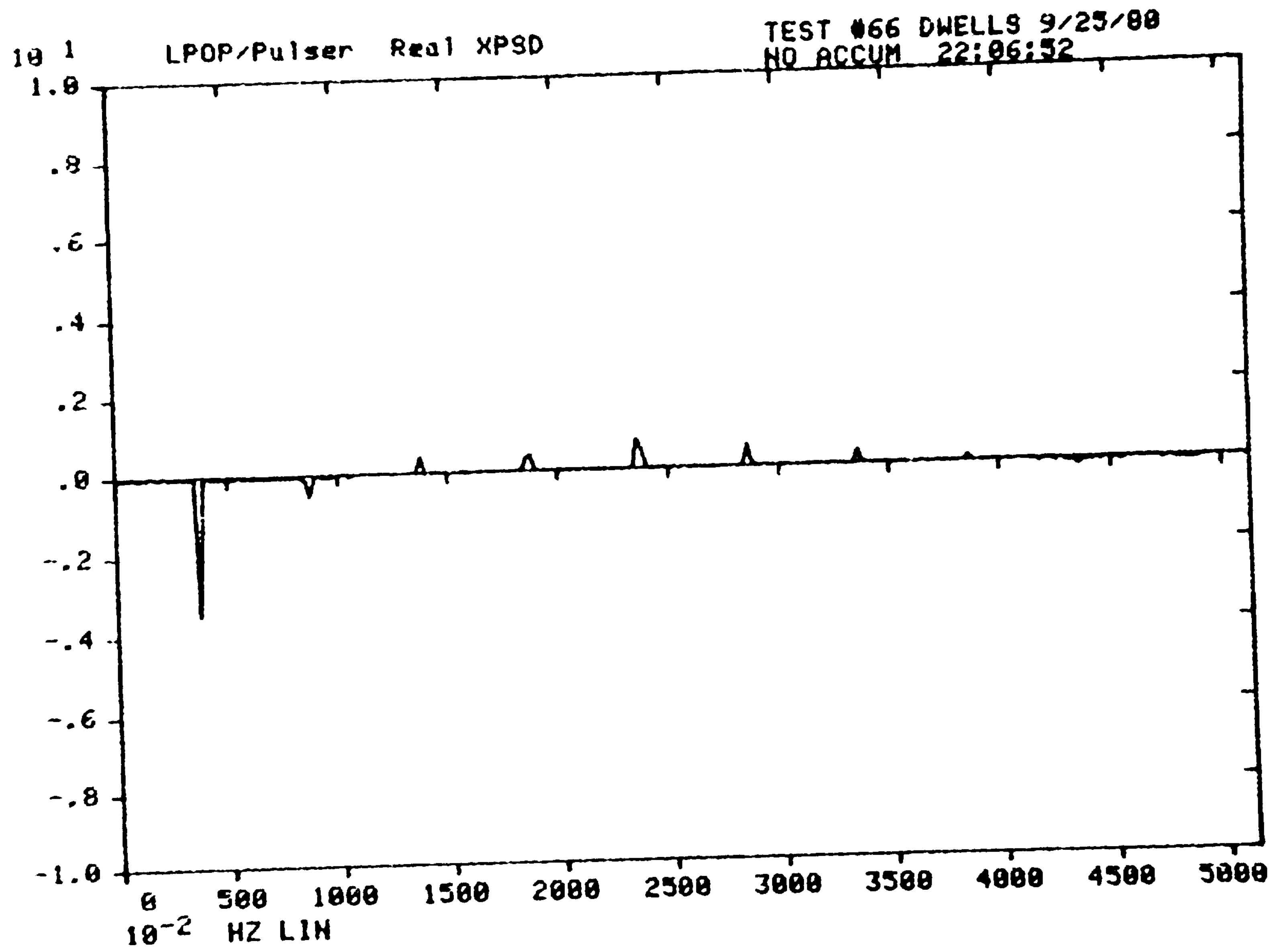


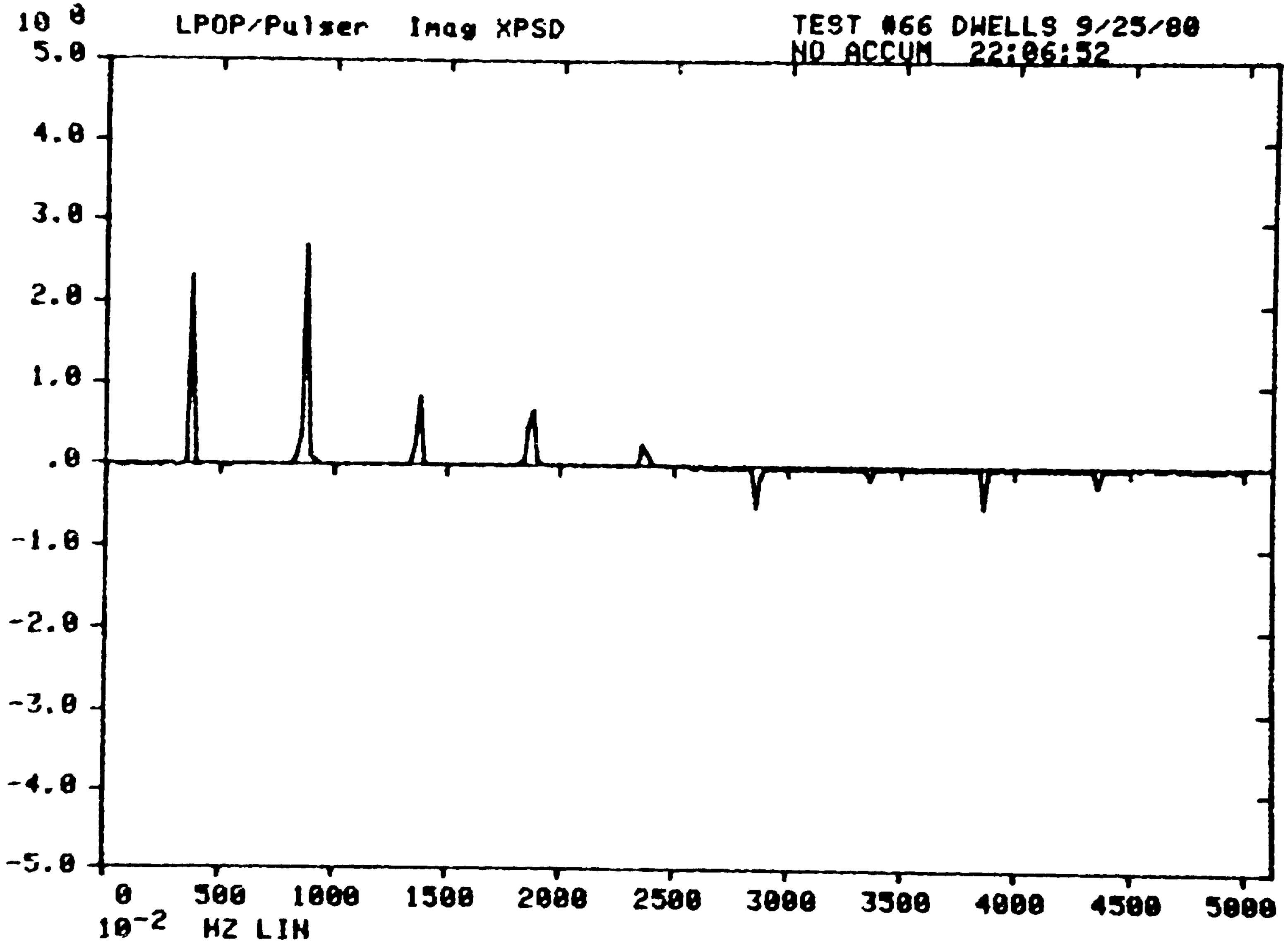
LPOP/Pulser H(f) - Polar
TEST #66 DWELLS 9/25/80
NO ACCUM 22:06:52
10^N
2
1
0
-1
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
10^{-2} HZ LIN

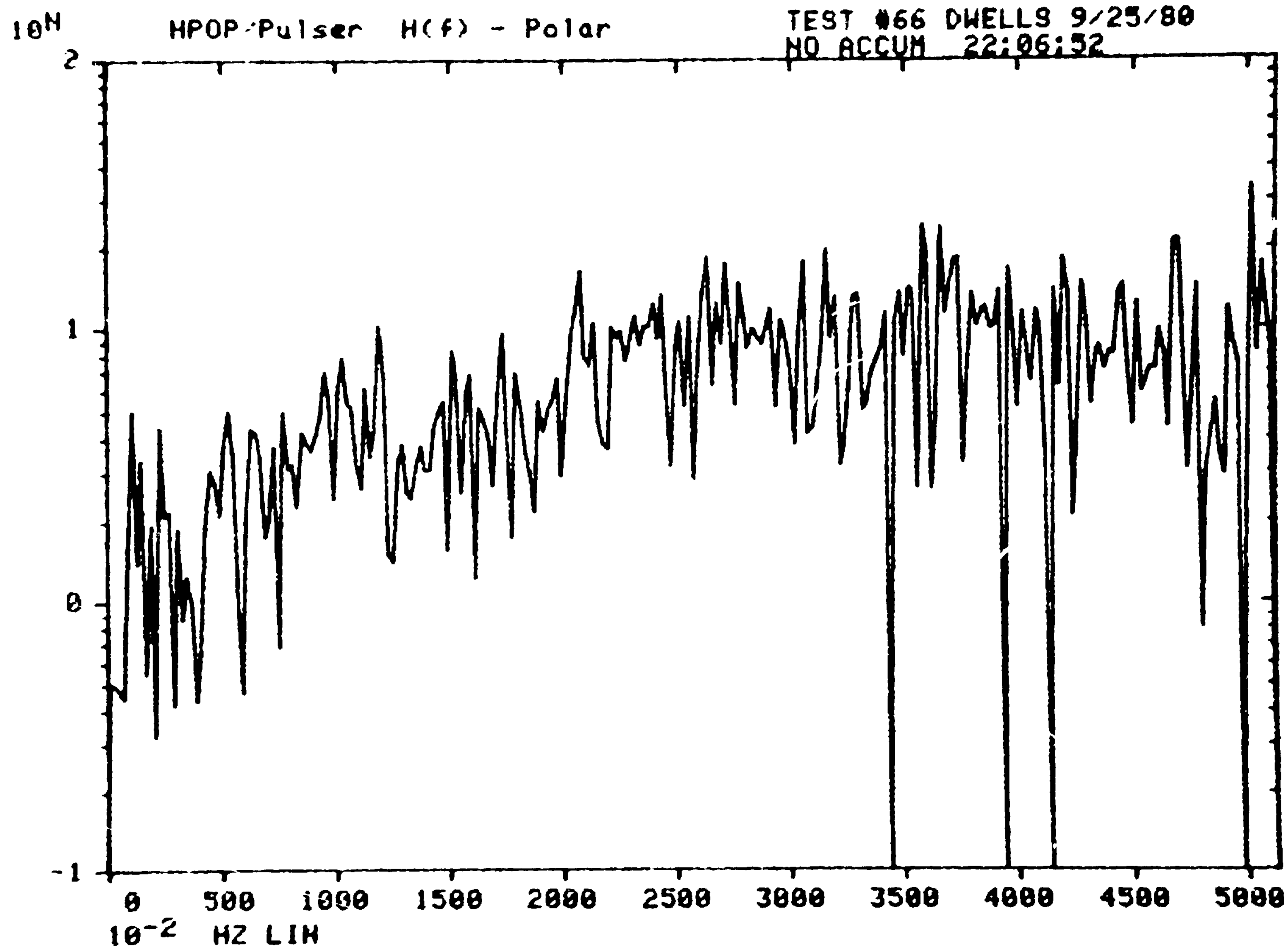

10 1
LPOP/Pulser H(f) - Polar
TEST #66 DWELLS 9/25/80
NO ACCUM 22:06:52
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
.5
.0
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
10-2 HZ LIN


DEG LPOP/Pulser H(f) - Polar
TEST #66 DWELLS 9/25/80
NO ACCUM 22:06:52
180
135
90
45
0
-45
-90
-135
-180
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
10^-2 HZ LIN


10 0
LPOP/Pulser Coh(f)
TEST #66 DWELLS 9/25/80
NO ACCUM 22:06:52
2.0
1.6
1.2
.8
.4
.0
-.4
-.8
-1.2
-1.6
-2.0
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
10-2 HZ LIN

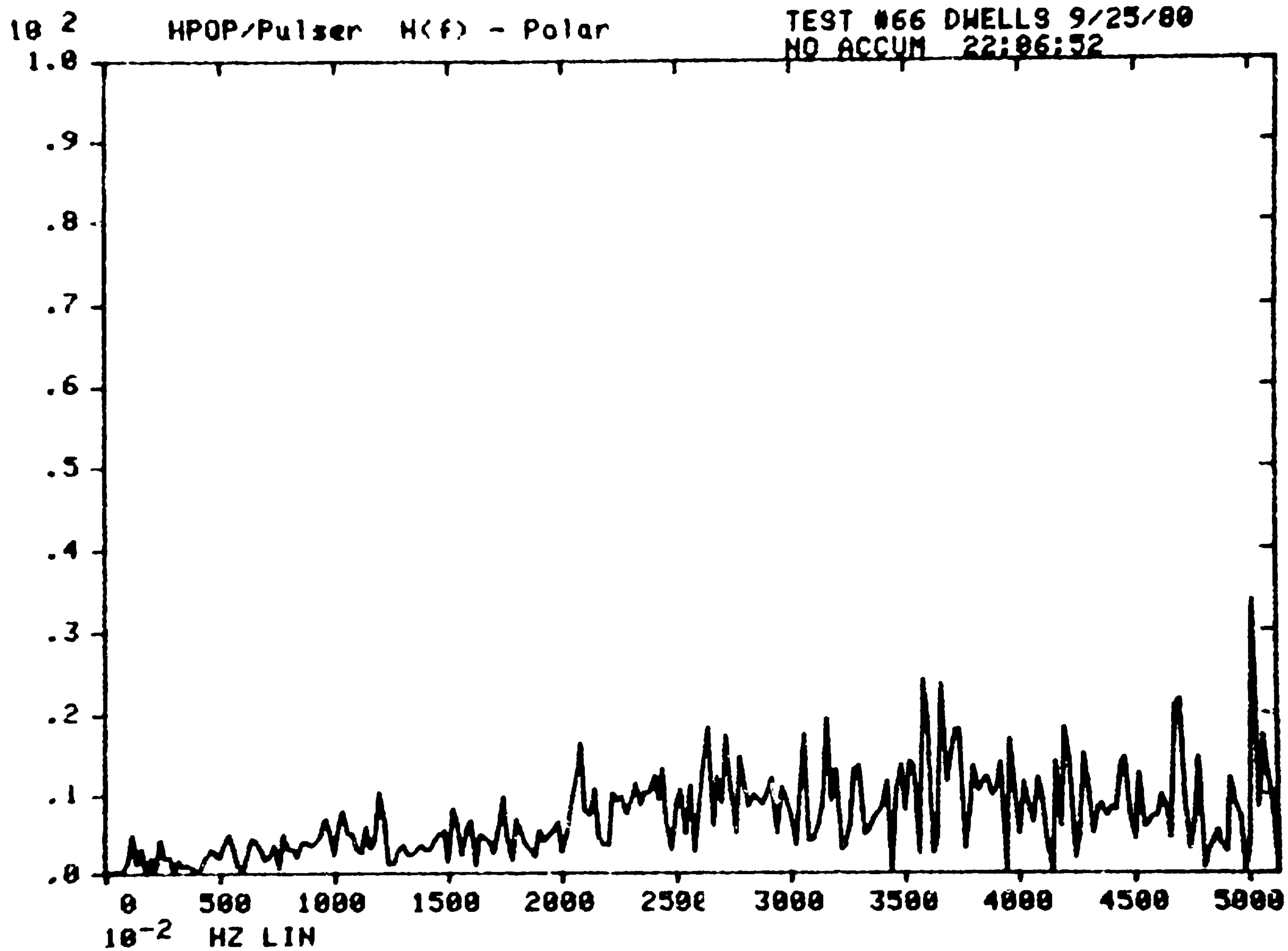

LPOP/Pulser Real XPSD
TEST #66 DWELLS 9/25/80
NO ACCUM 22:06:52
10^{1}
1.0
.8
.6
.4
.2
.0
-.2
-.4
-.6
-.8
-1.0
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
10^{-2} HZ LIN

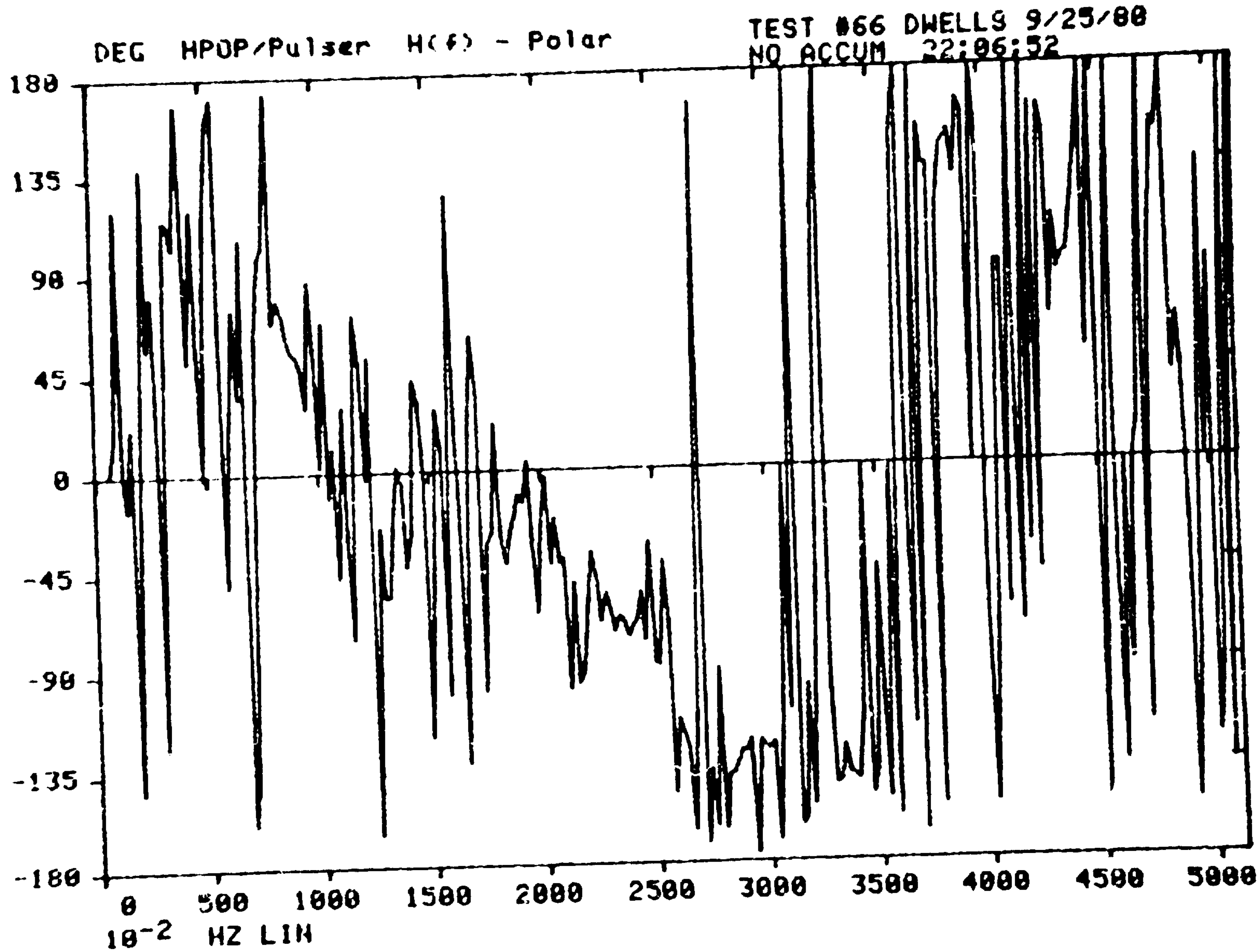

10 0
LPOP/Pulser Imag XPSD
TEST #66 DWELLS 9/25/80
NO ACCUM 22:06:52
5.0
4.0
3.0
2.0
1.0
.0
-1.0
-2.0
-3.0
-4.0
-5.0
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
10^-2 HZ LIN



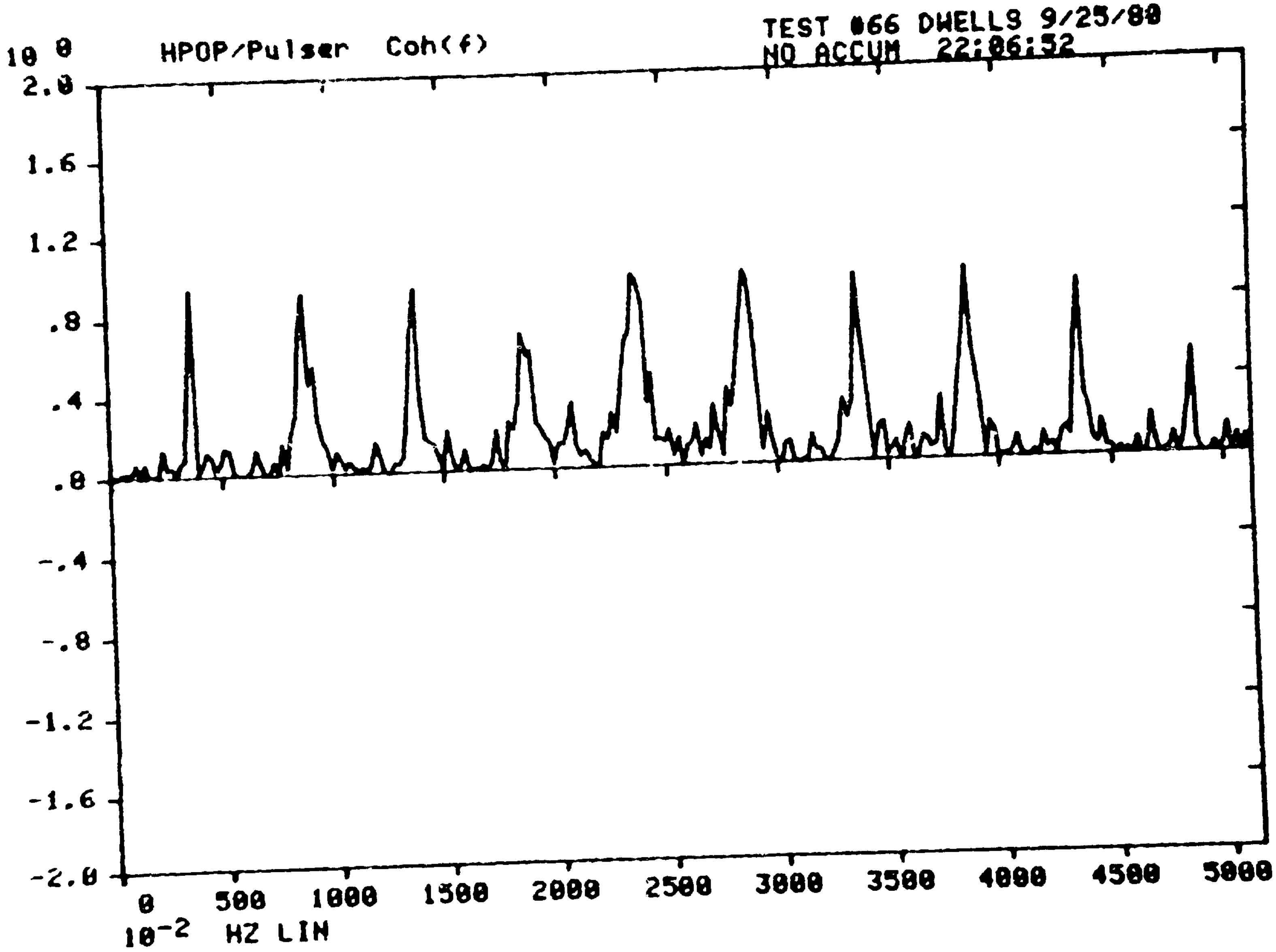
10^N
HPOP-Pulser H(f) - Polar
TEST #66 DWELLS 9/25/80
NO ACCUM 22:06:52
2
1
0
-1
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
10^-2 HZ LIN

E35

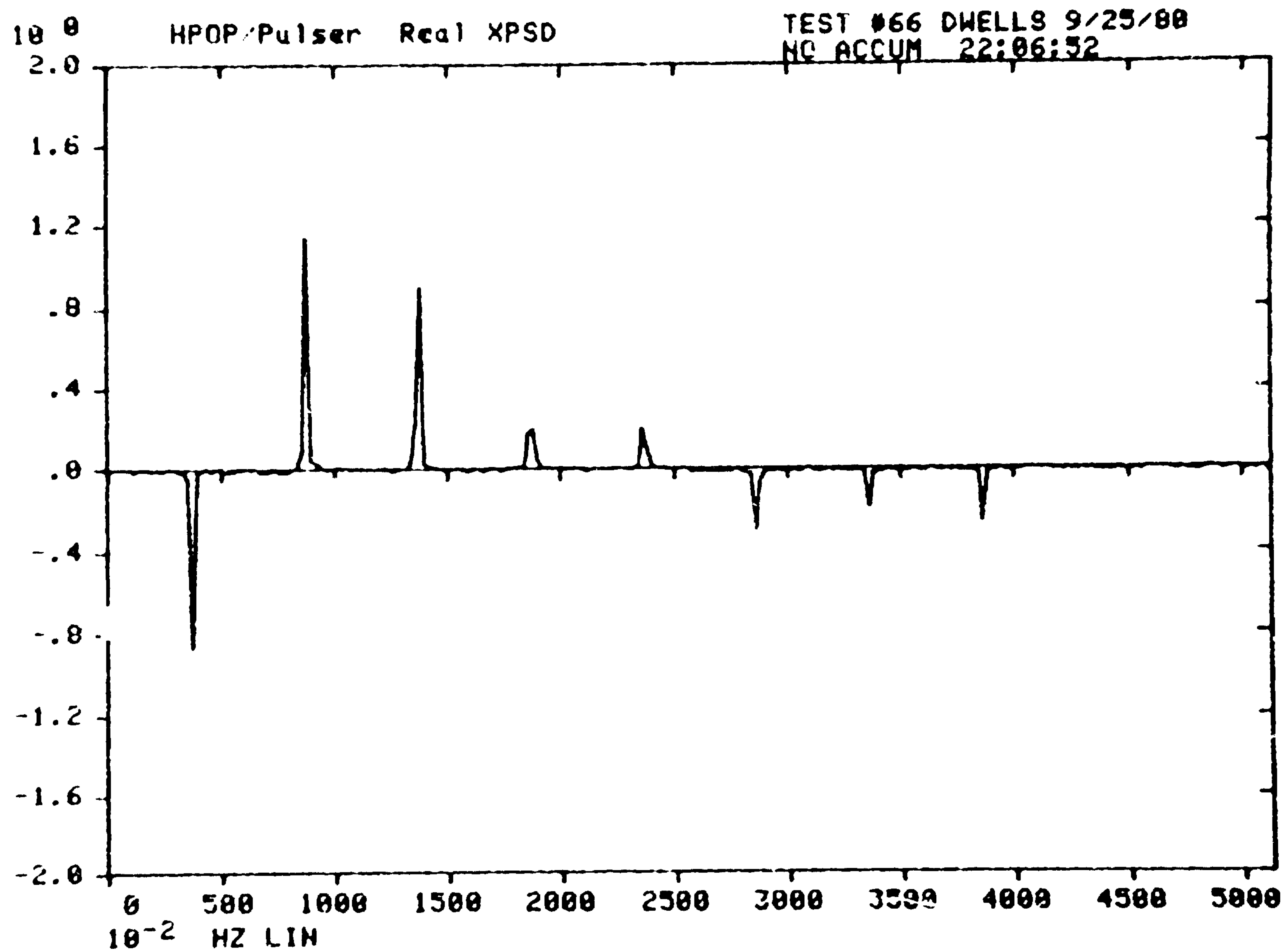

10 2
HPOP/Pulser H(f) - Polar
TEST #66 DWELLS 9/25/80
NO ACCUM 22:06:52
1.0
.9
.8
.7
.6
.5
.4
.3
.2
.1
.0
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
10^-2 HZ LIN


DEG HPDP/Pulser H(f) - Polar
TEST #66 DWELLS 9/25/80
NO ACCUM 22:06:52
180
135
90
45
0
-45
-90
-135
-180
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
10^{-2} HZ LIN

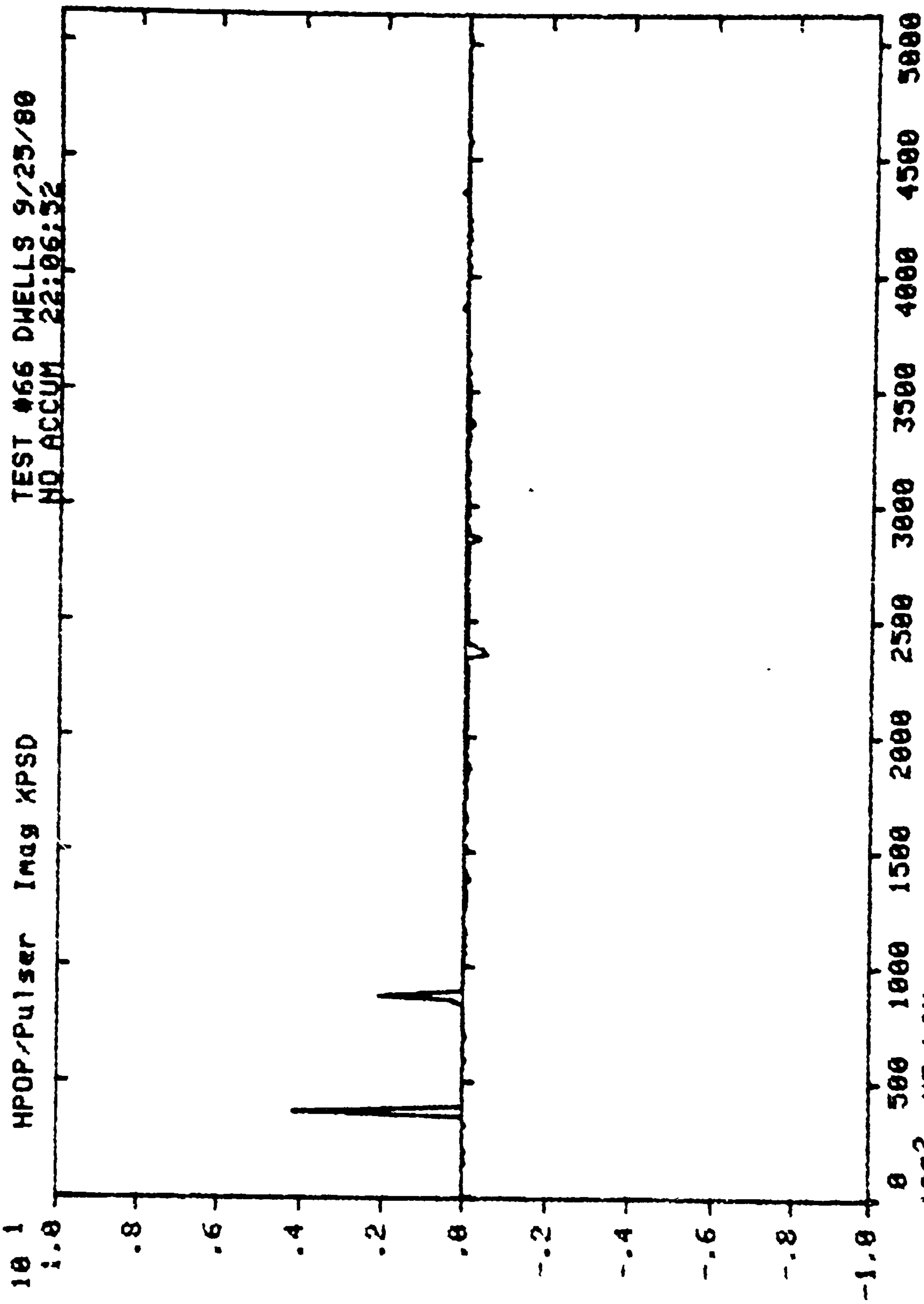
E38

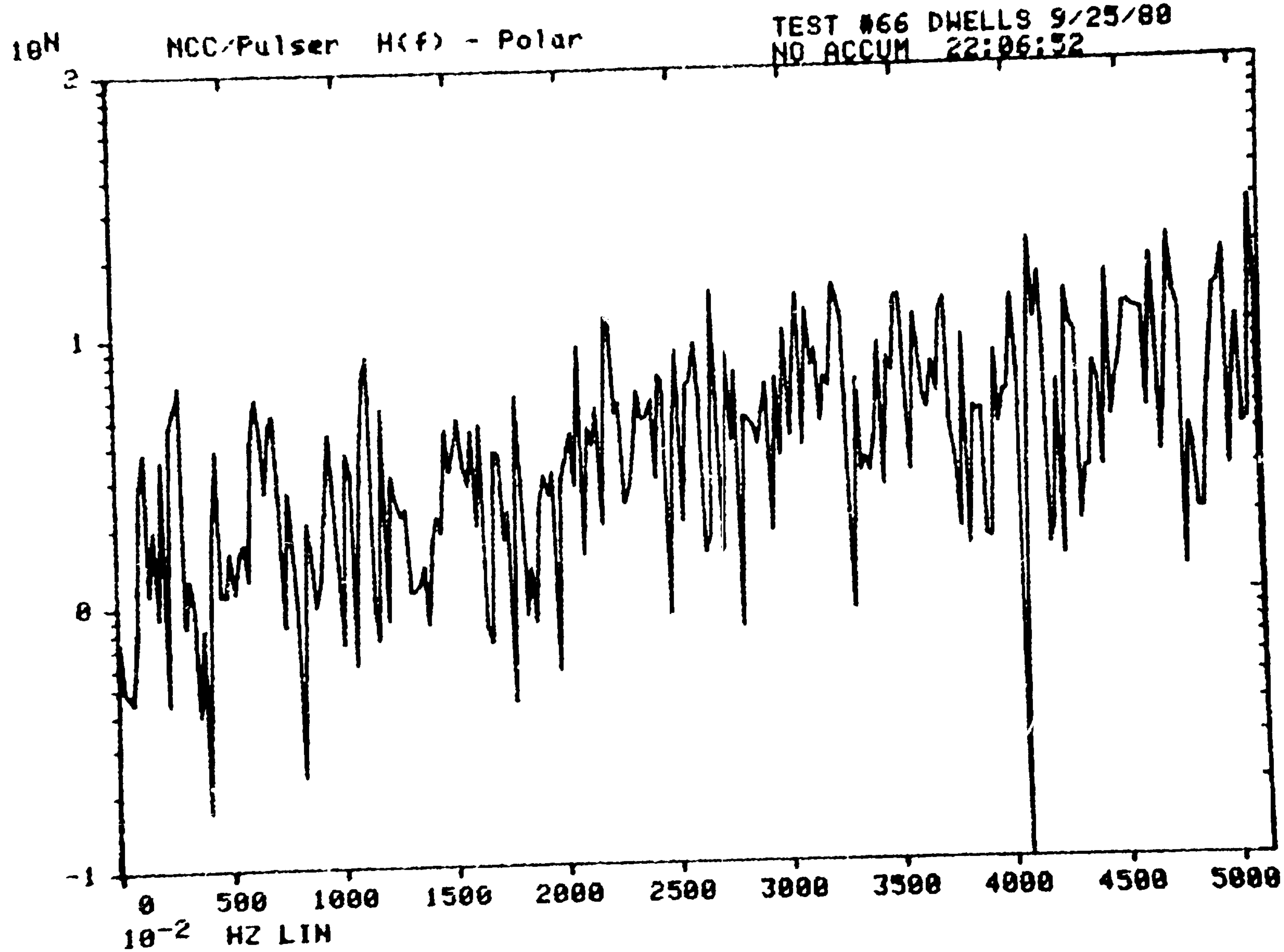


TEST #66 DWELLS 9/25/80
NO ACCUM 22:06:52
10 0
HPOP/Pulser Coh(f)
2.0
1.6
1.2
.8
.4
.0
-.4
-.8
-1.2
-1.6
-2.0
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
10^{-2} HZ LIN

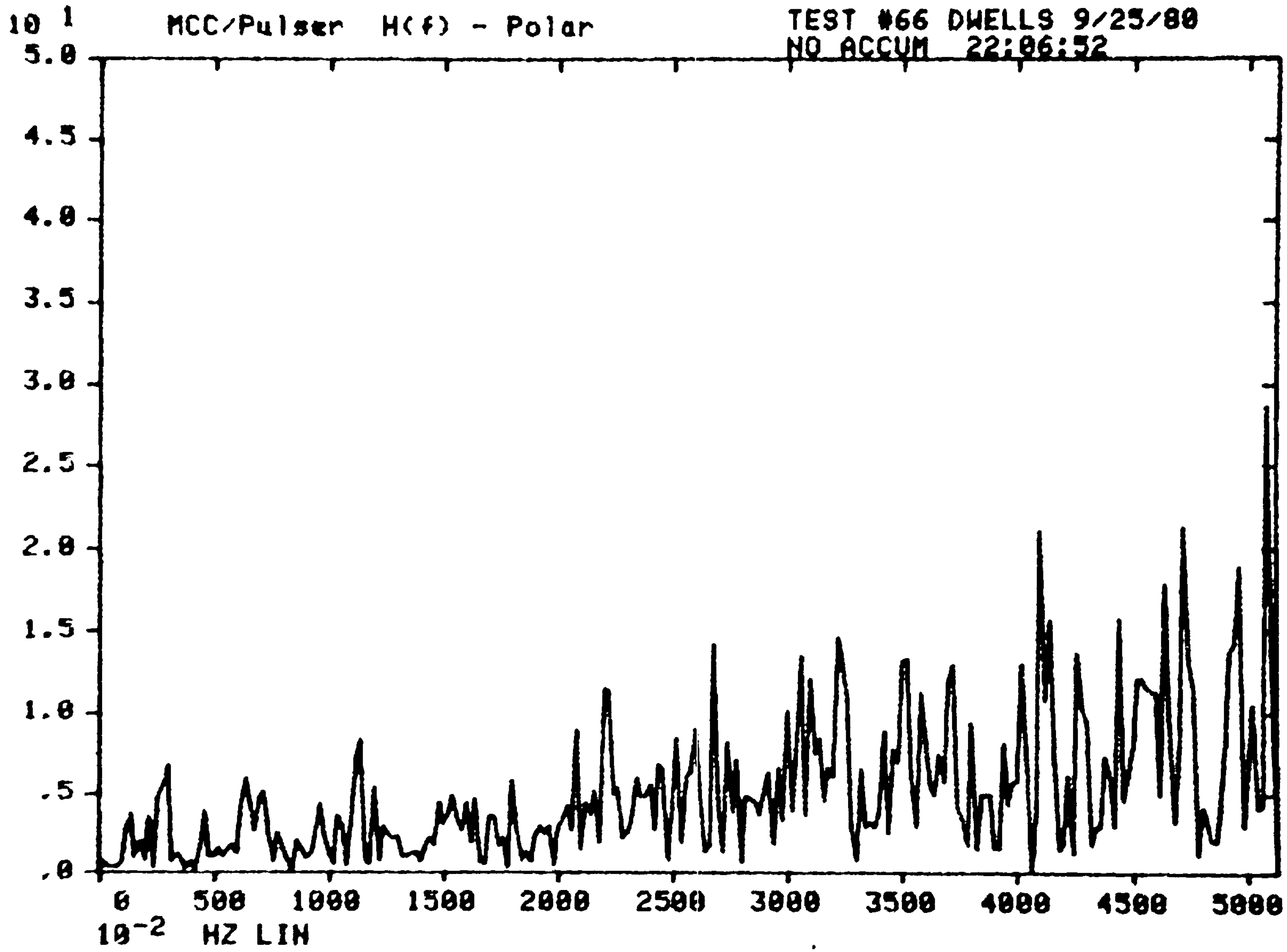

HPOP/Pulser Real XPSD
TEST #66 DWELLS 9/25/80
NO ACCUM 22:06:52
10 0
2.0
1.6
1.2
.8
.4
.0
-.4
-.8
-1.2
-1.6
-2.0
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
10^{-2} HZ LIN

E40

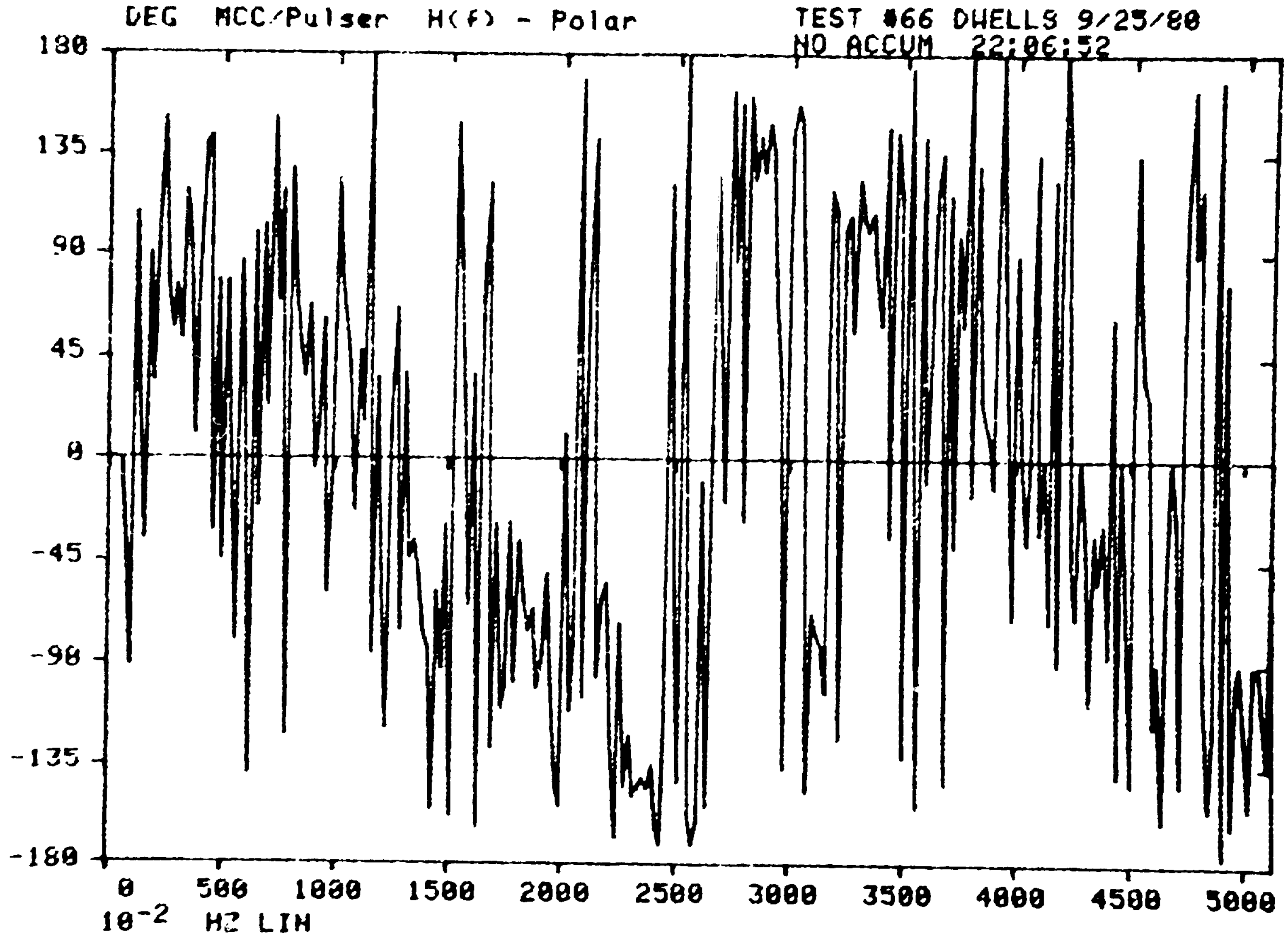

HPOP/Pulser Imag XPSD
TEST #66 DWELLS 9/25/80
NO ACCUM 22:06:52
10 1
1.0
.8
.6
.4
.2
.0
-.2
-.4
-.6
-.8
-1.0
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
10-2 HZ LIN

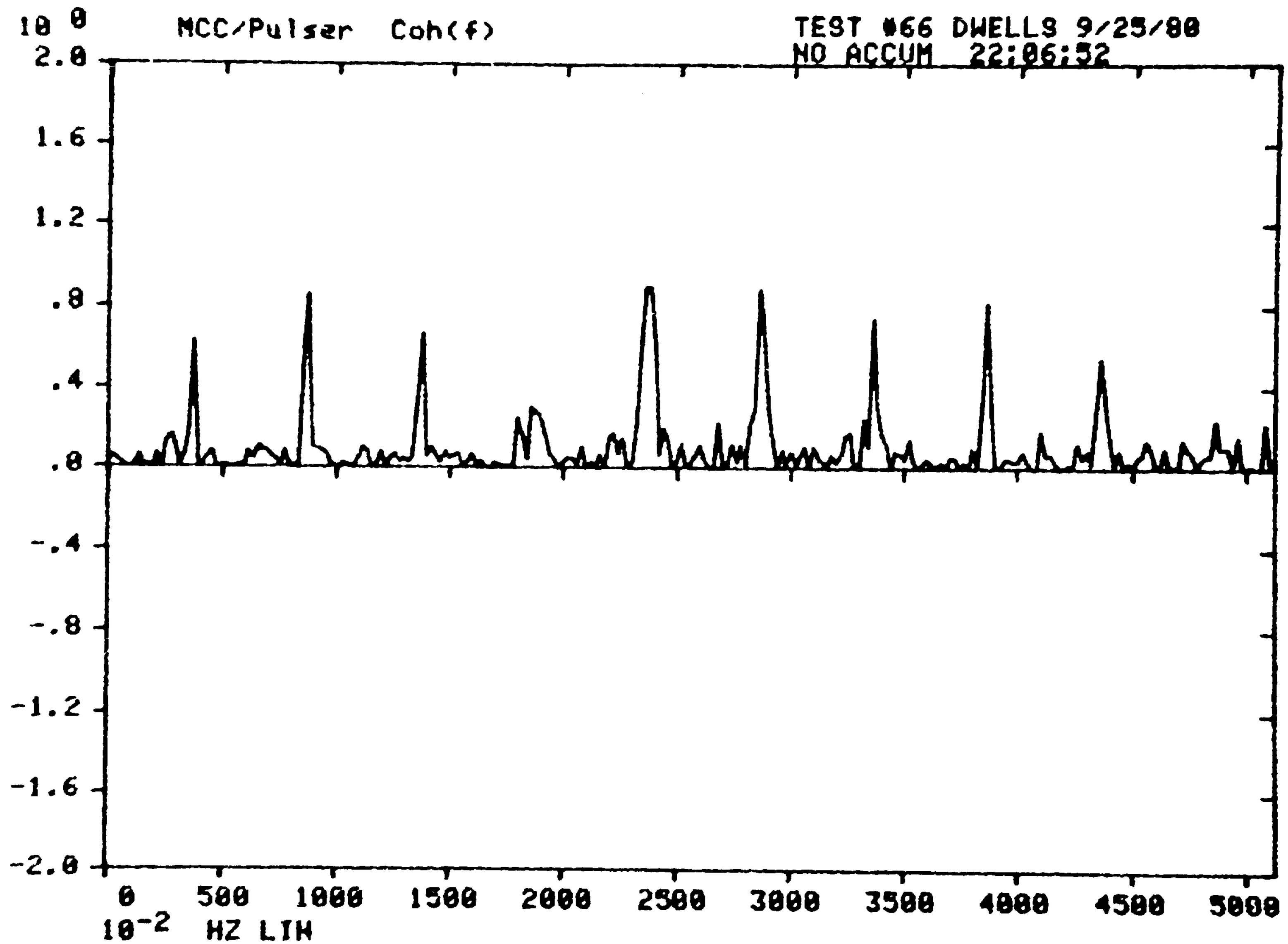


MCC/Pulser H(f) - Polar
TEST #66 DWELLS 9/25/80
NO ACCUM 22:06:52
10^N
2
1
0
-1
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
10^-2 HZ LIN



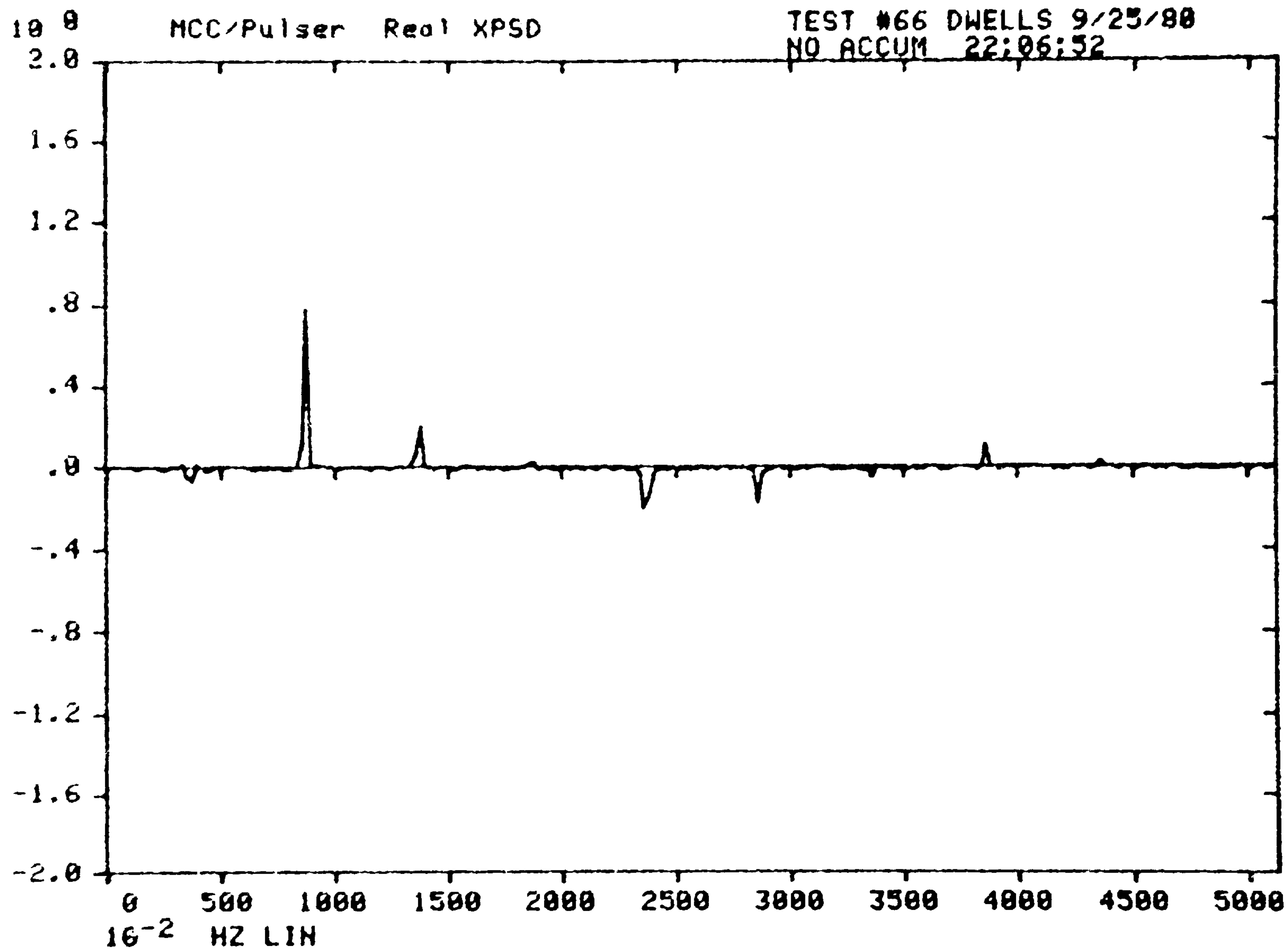
MCC/Pulser H(f) - Polar
TEST #66 DWELLS 9/25/80
NO ACCUM 22:06:52
10 1
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
.5
.0
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
10-2 HZ LIN

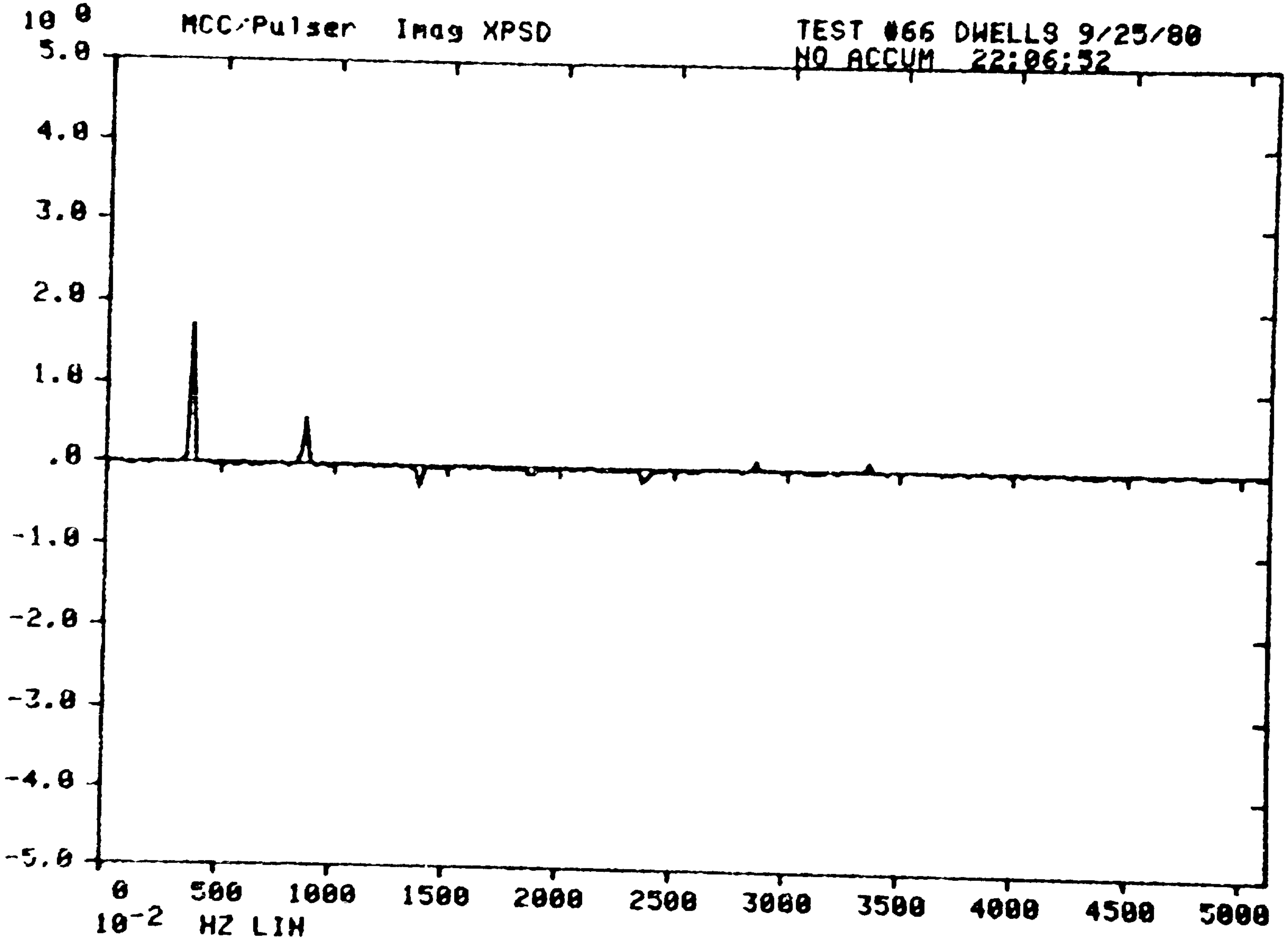

DEG MCC/Pulser H(f) - Polar
TEST #66 DWELLS 9/25/80
NO ACCUM 22:06:52
180
135
90
45
0
-45
-90
-135
-180
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
10^{-2} HZ LIN

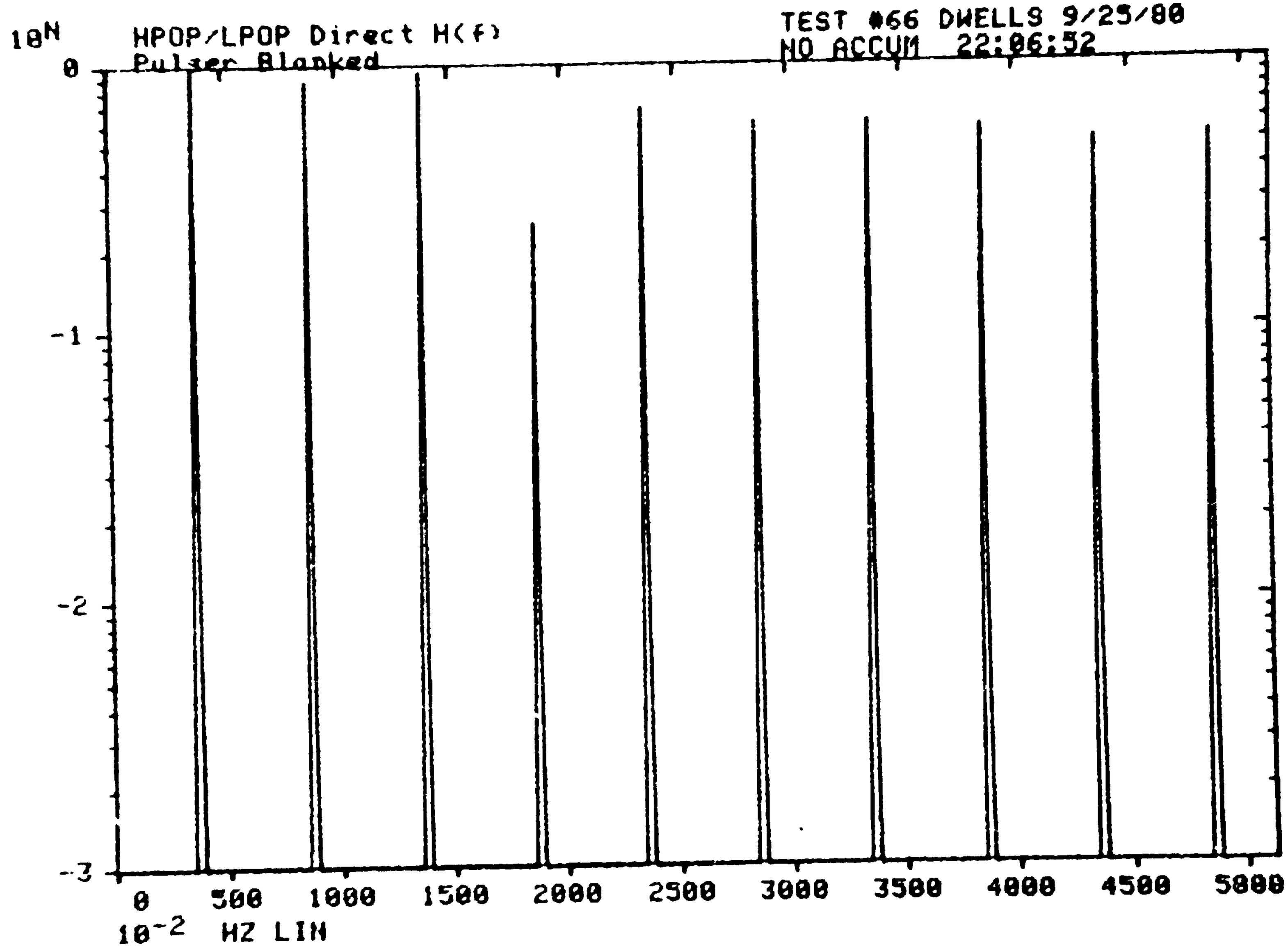


10 0
MCC/Pulser Coh(f)
TEST #66 DWELLS 9/25/80
NO ACCUM 22:06:52
2.0
1.6
1.2
.8
.4
.0
-.4
-.8
-1.2
-1.6
-2.0
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
10^-2 HZ LIN

E44


10 0
MCC/Pulser Real XPSD
TEST #66 DWELLS 9/25/80
NO ACCUM 22:06:52
2.0
1.6
1.2
.8
.4
.0
-.4
-.8
-1.2
-1.6
-2.0
0 500 1000 1500 2000 2500 3000 3500 4000 4500 5000
10^-2 HZ LIN

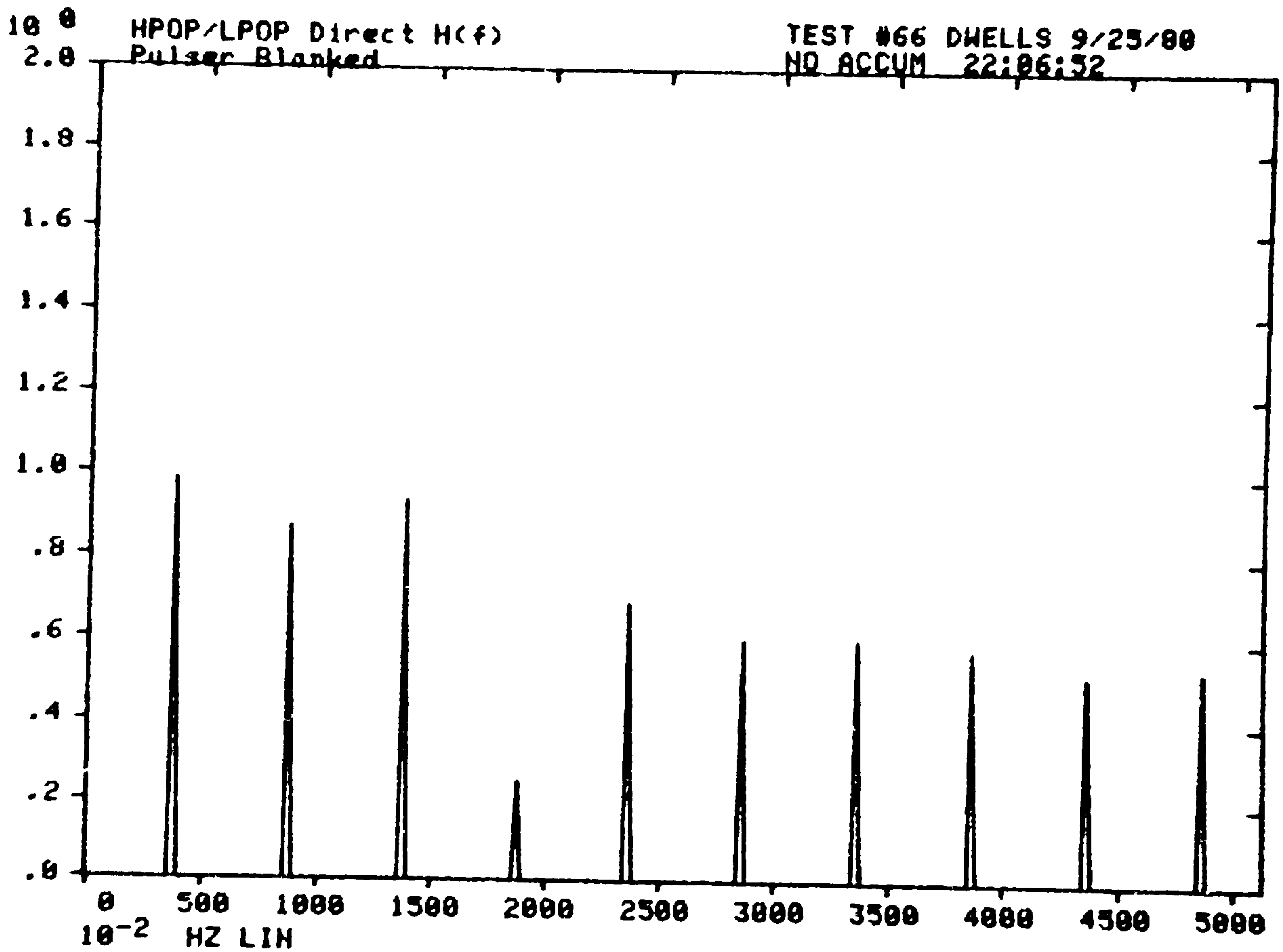

MCC/Pulser Imag XPSD
TEST #66 DWELLS 9/25/80
NO ACCUM 22:06:52
10 0
5.0
4.0
3.0
2.0
1.0
.0
-1.0
-2.0
-3.0
-4.0
-5.0
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
10^{-2} HZ LIN

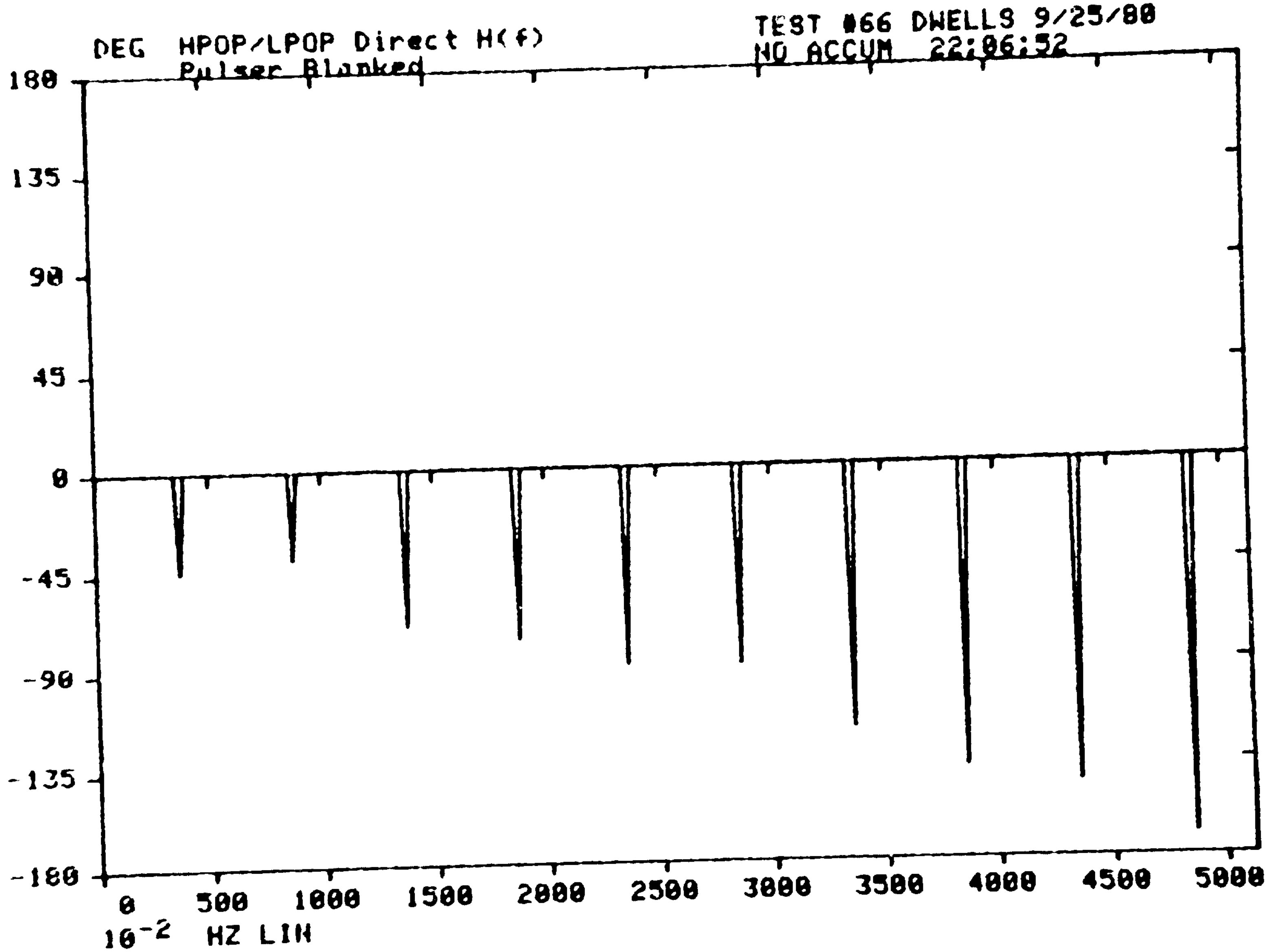


10^N
HPOP/LPOP Direct H(f)
Pulser Blanked
TEST #66 DWELLS 9/25/80
NO ACCUM 22:06:52
0
-1
-2
-3
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
10^{-2} HZ LIN

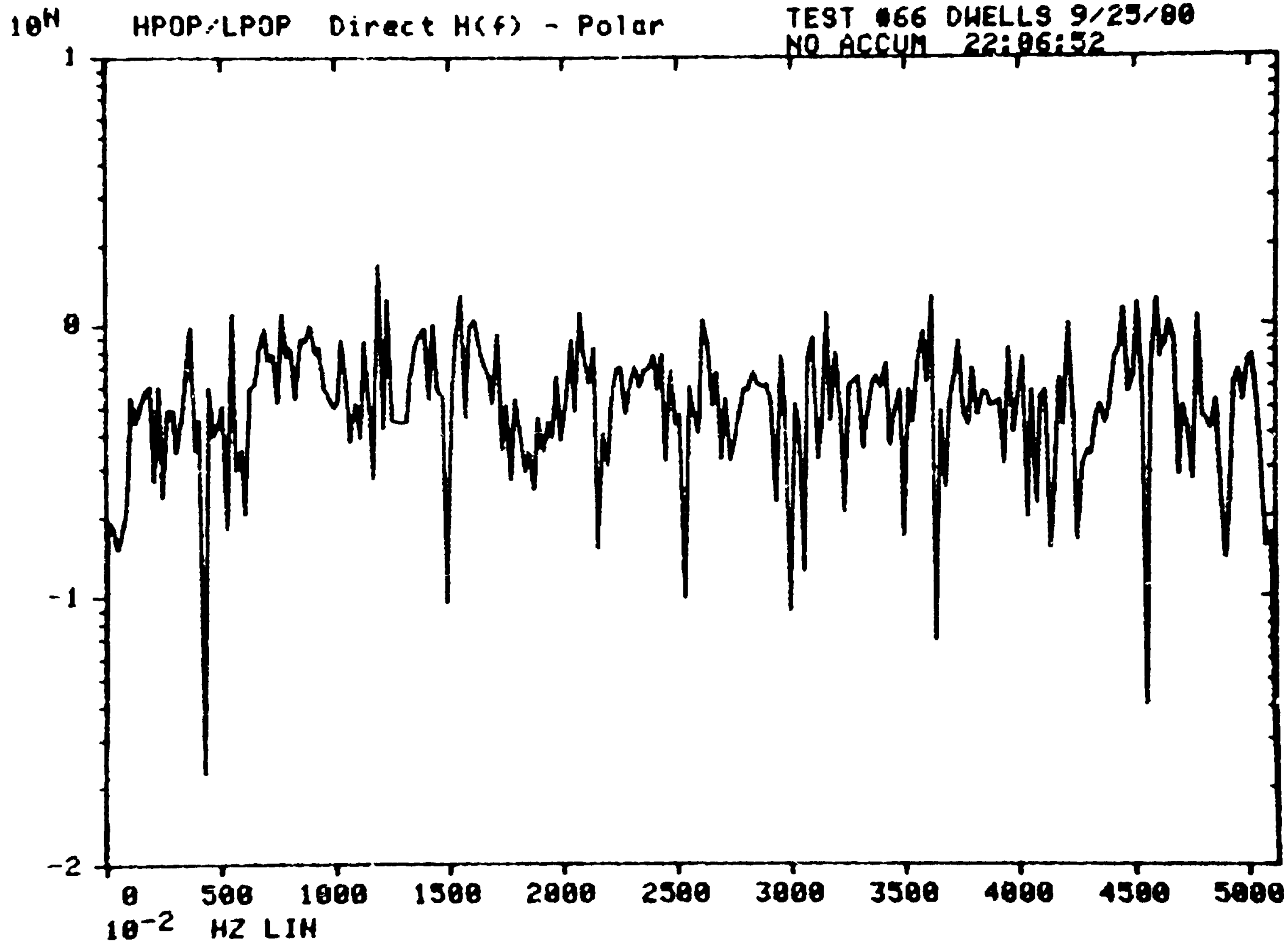
E47

E48

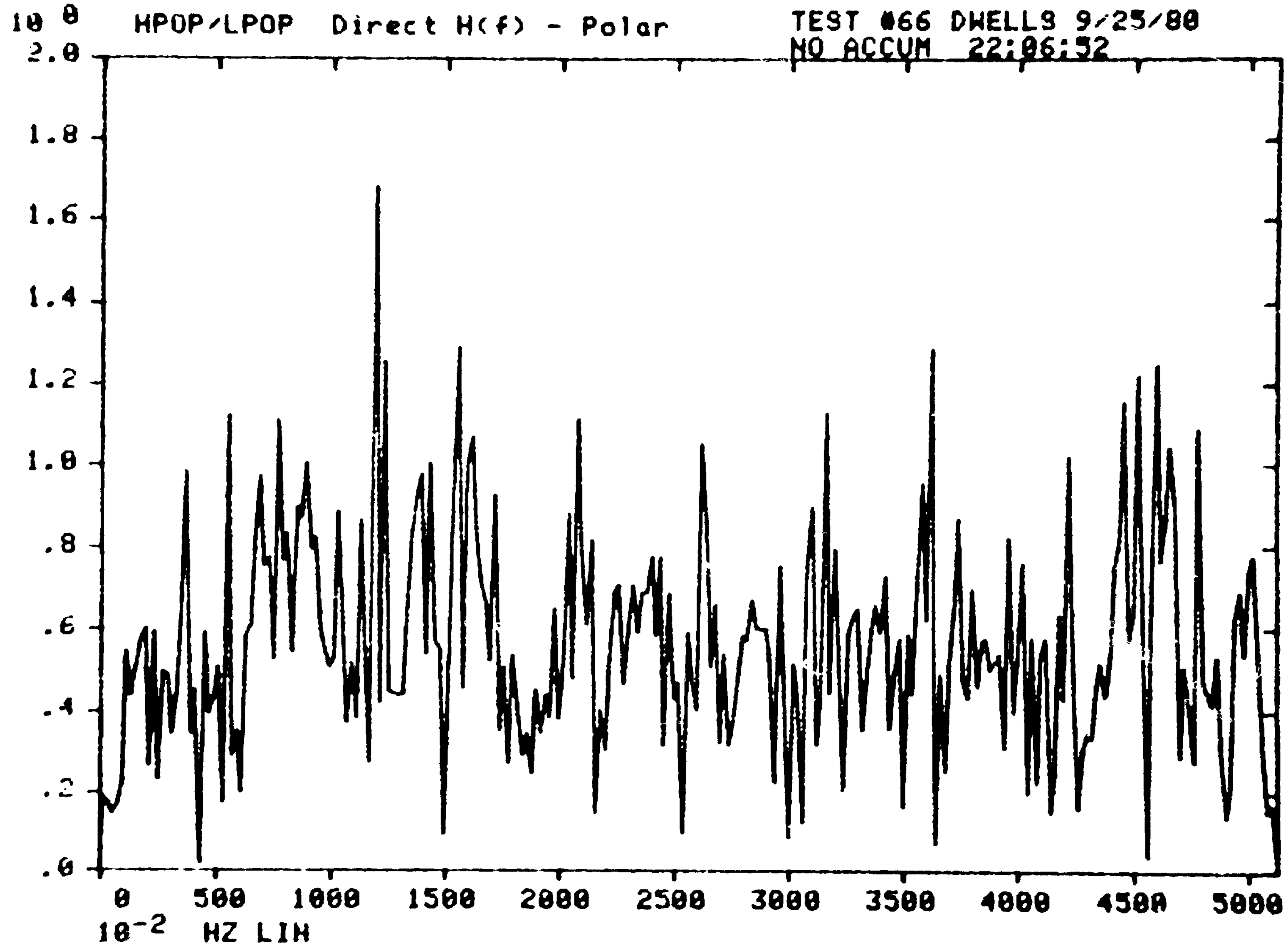

10 0
HPOP/LPOP Direct H(f)
Pulser Blanked
TEST #66 DWELLS 9/25/80
NO ACCUM 22:06:52
2.0
1.8
1.6
1.4
1.2
1.0
.8
.6
.4
.2
.0
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
10^-2 HZ LIN



DEG
HPOP/LPOP Direct H(f)
Pulser Blanked
TEST #66 DWELLS 9/25/80
NO ACCUM 22:06:52
180
135
90
45
0
-45
-90
-135
-180
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
10^-2 HZ LIN

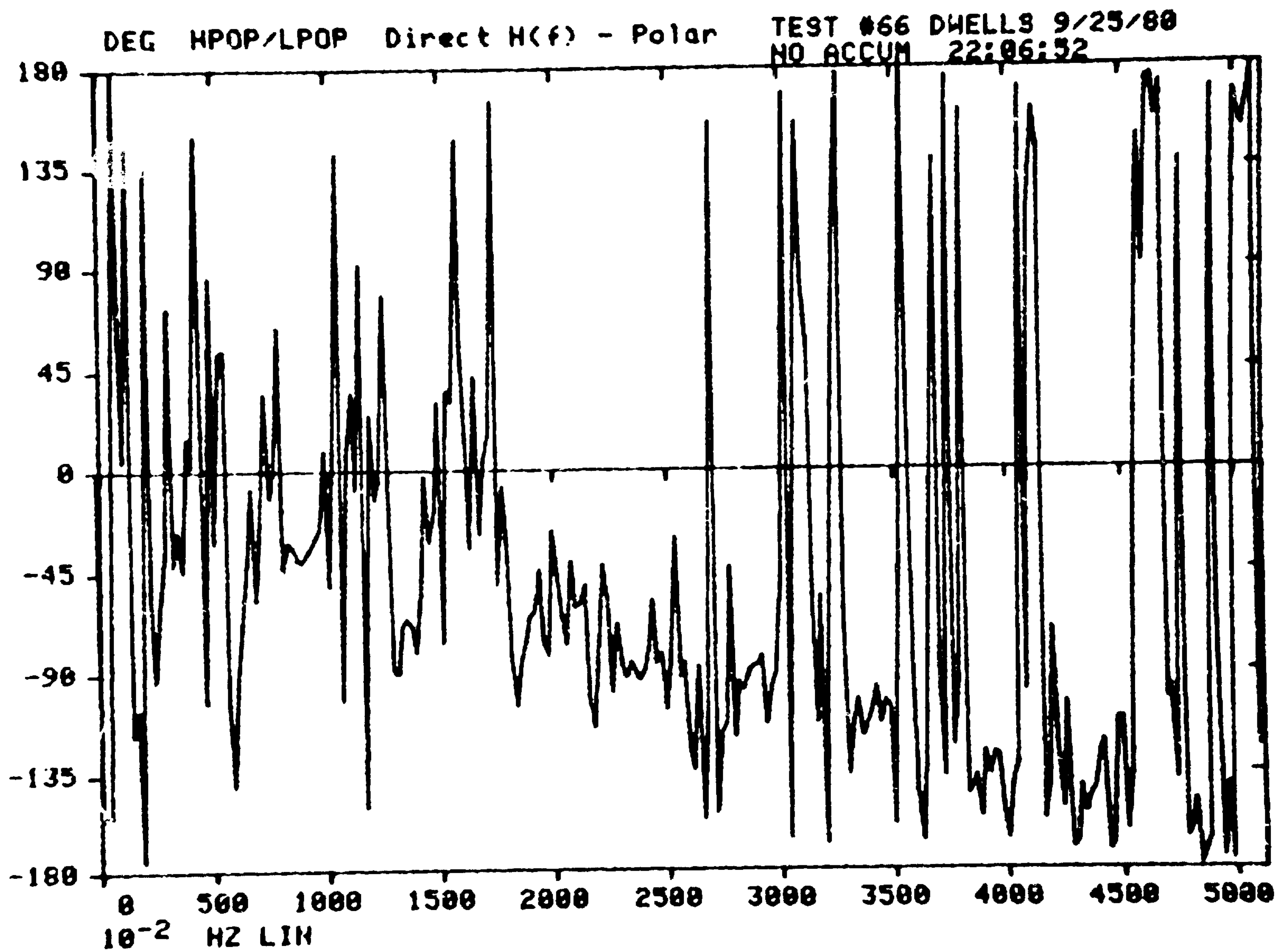


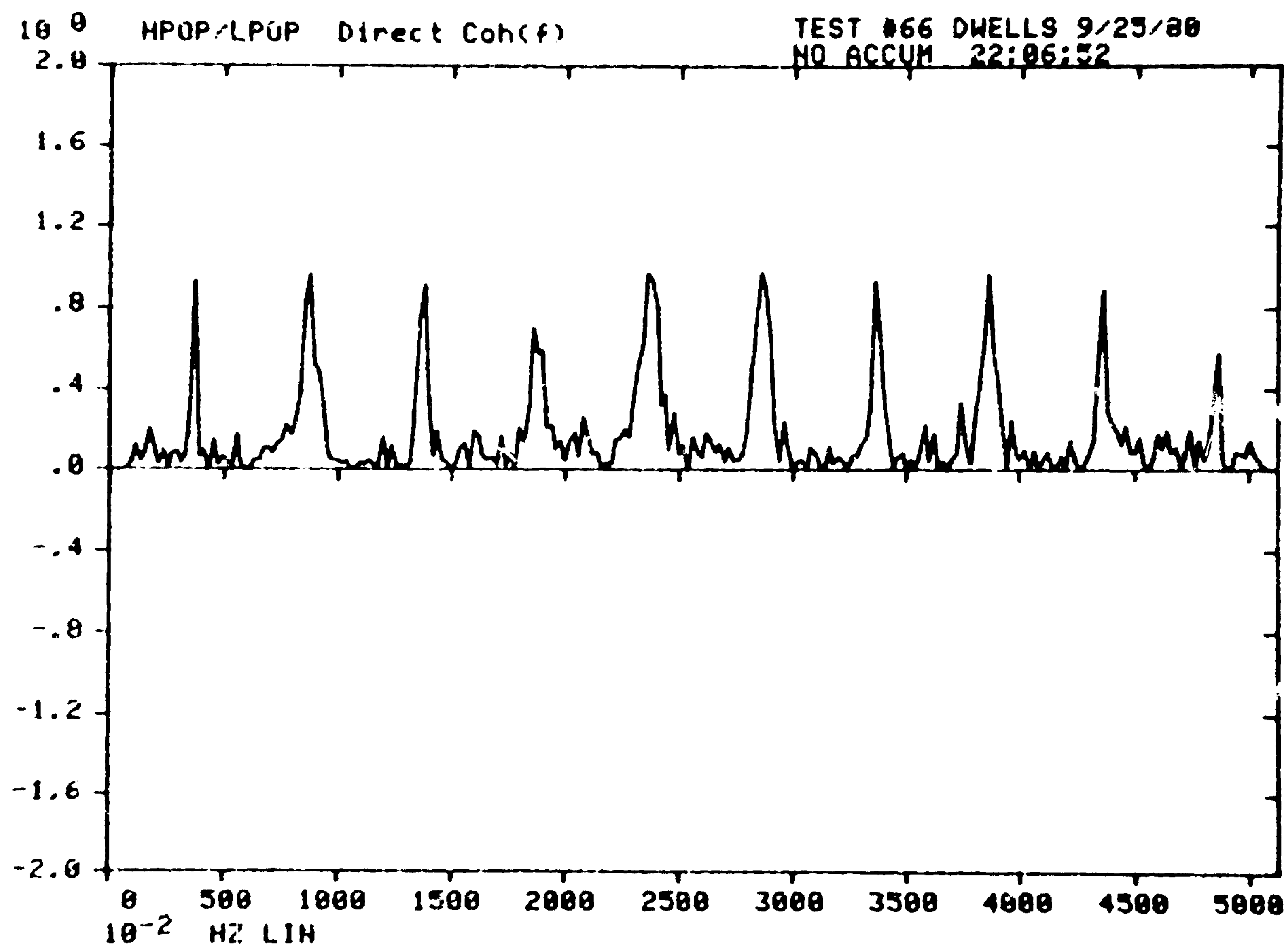
HPOP/LPOP Direct H(f) - Polar
TEST #66 DWELLS 9/25/80
NO ACCUM 22:06:52
10^N
1
0
-1
-2
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
10^-2 HZ LIN



10 0
HPOP/LPOP Direct H(f) - Polar
TEST #66 DWELLS 9/25/80
NO ACCUM 22:06:52
2.0
1.8
1.6
1.4
1.2
1.0
.8
.6
.4
.2
.0
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
10^-2 HZ LIN

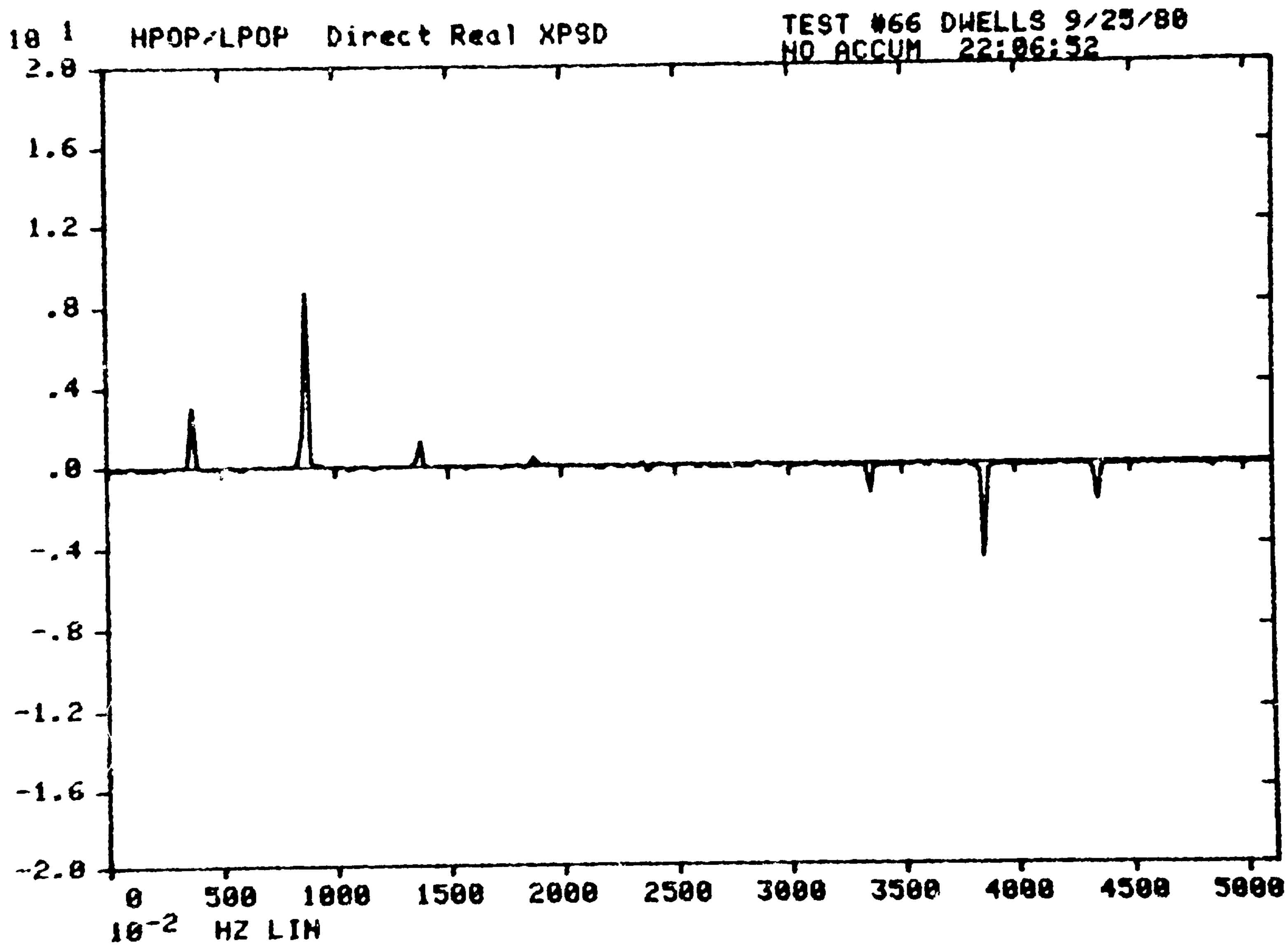
E51


DEG HPOP/LPOP Direct H(f) - Polar
TEST #66 DWELLS 9/25/80
NO ACCUM 22:06:52
180
135
90
45
0
-45
-90
-135
-180
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
10-2 HZ LIN

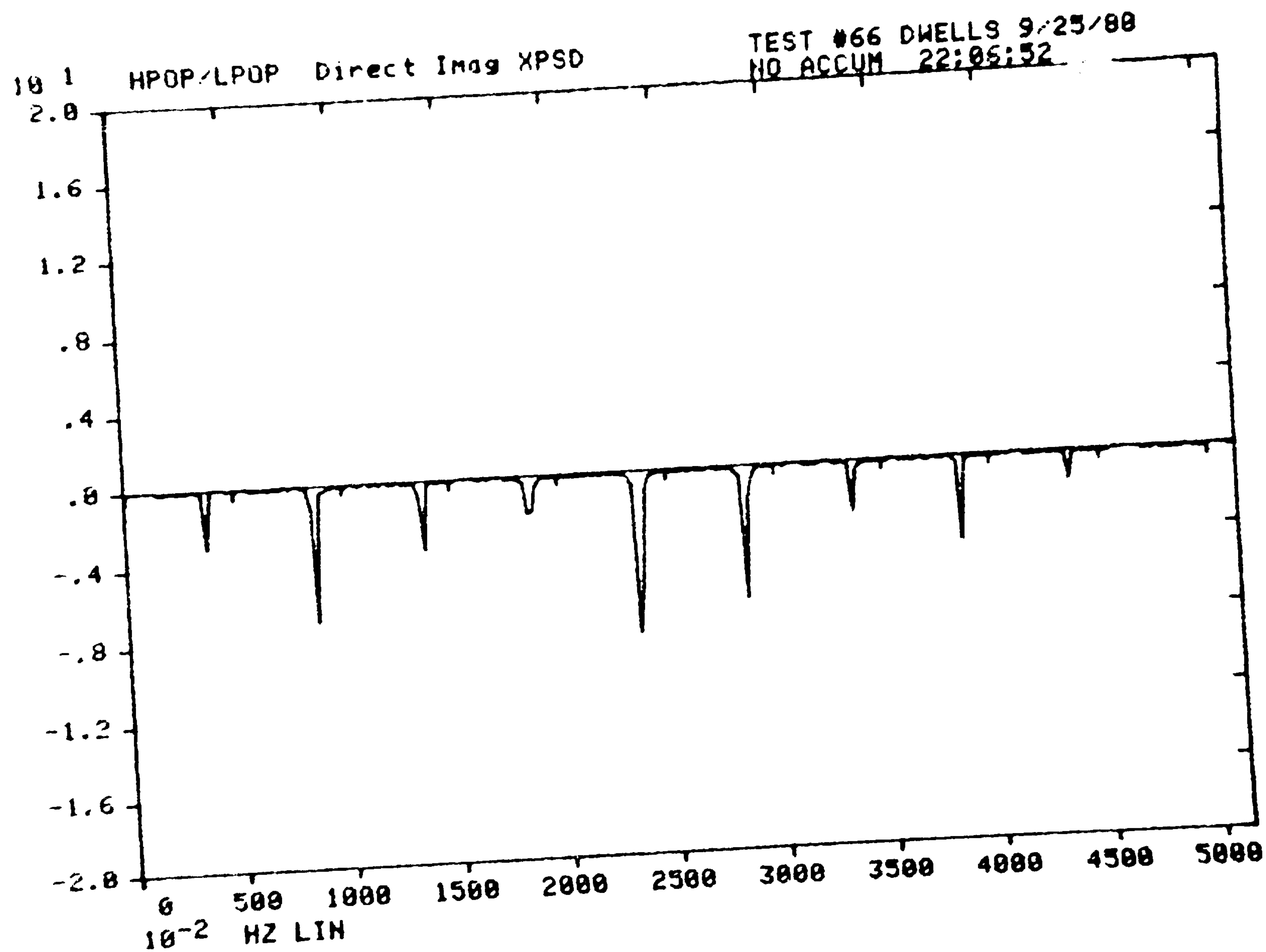


HPOP/LPOP Direct Coh(f)
TEST #66 DWELLS 9/25/80
NO ACCUM 22:06:52
10 0
2.0
1.6
1.2
.8
.4
.0
-.4
-.8
-1.2
-1.6
-2.0
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
10^-2 HZ LIN

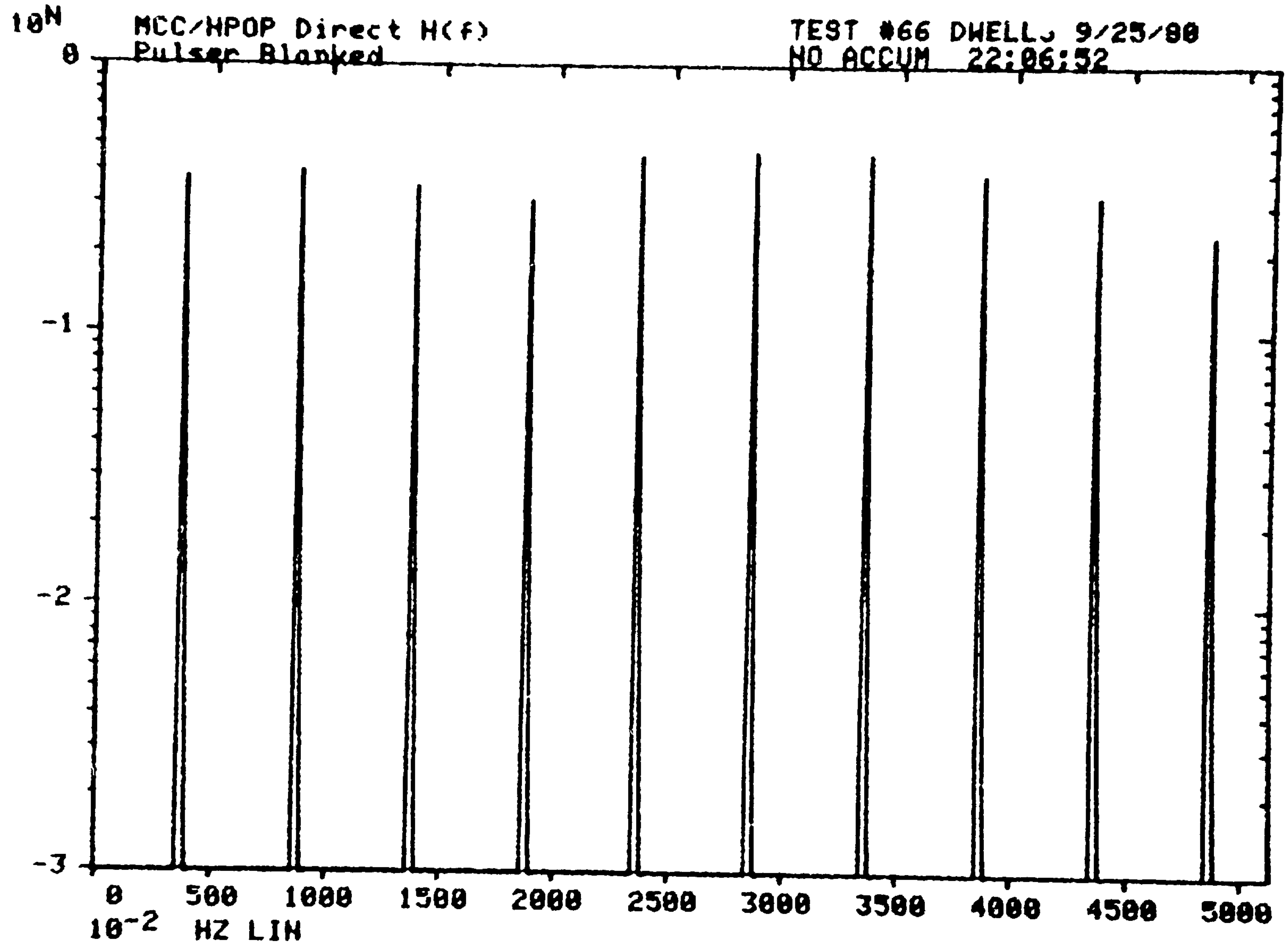
E54



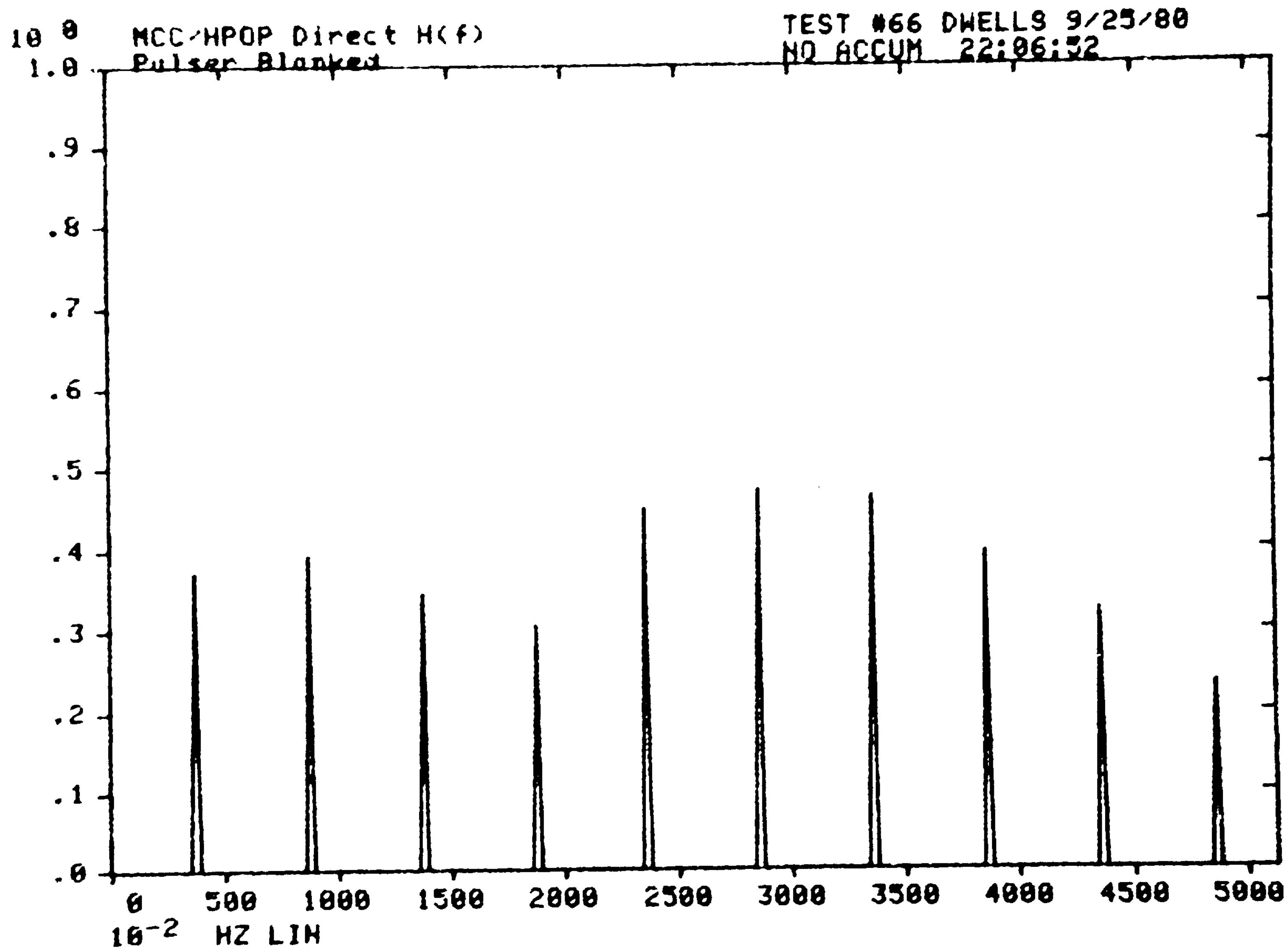
HPOP/LPOP Direct Real XPSD
TEST #66 DWELLS 9/25/80
NO ACCUM 22:06:52
10 1
2.0
1.6
1.2
.8
.4
.0
-.4
-.8
-1.2
-1.6
-2.0
0 500 1000 1500 2000 2500 3000 3500 4000 4500 5000
10^-2 HZ LIN

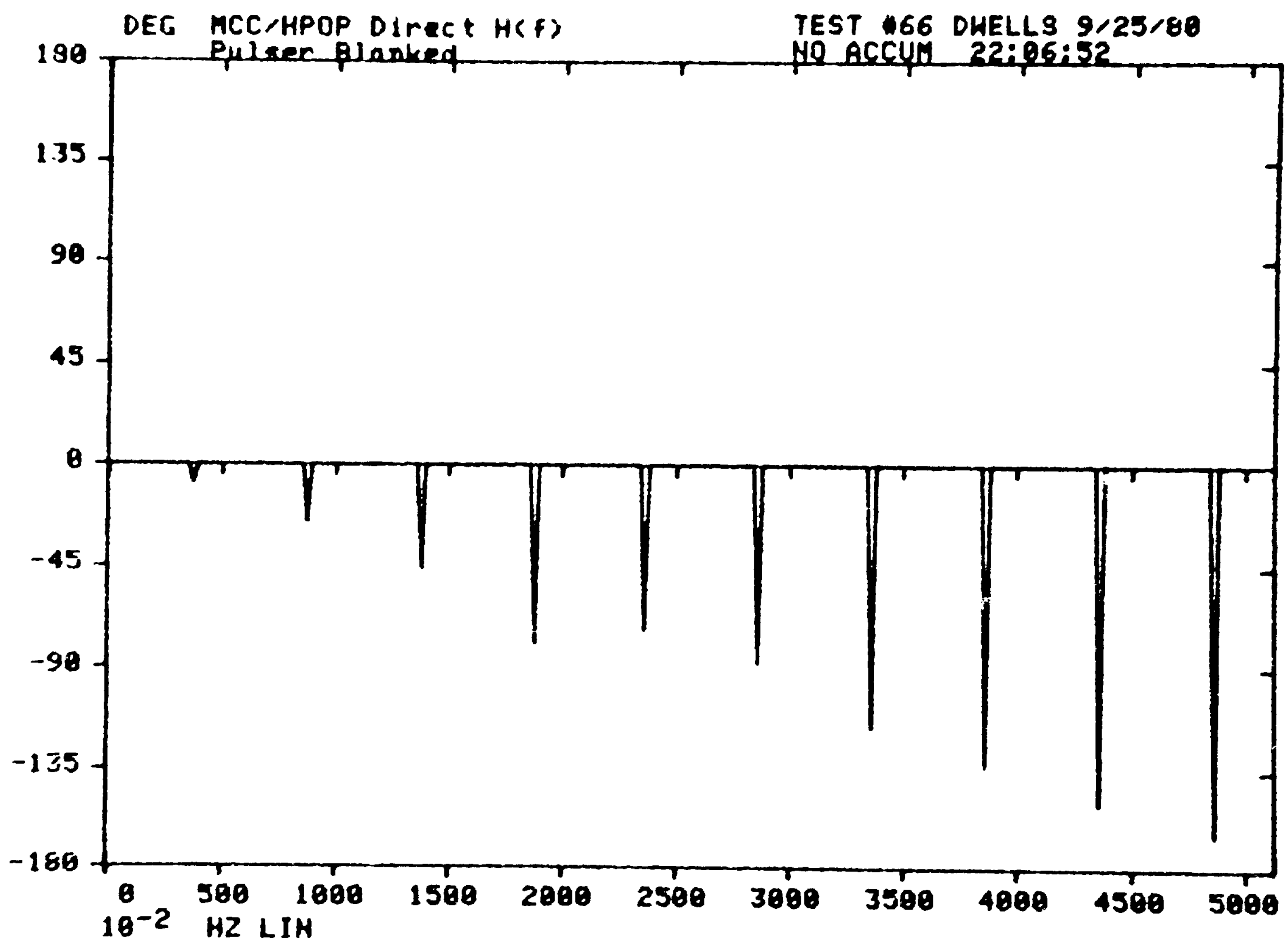

HPOP/LPOP Direct Imag XPSD
TEST #66 DWELLS 9/25/80
NO ACCUM 22:05:52
10 1
2.0
1.6
1.2
.8
.4
.0
-.4
-.8
-1.2
-1.6
-2.0
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
10^-2 HZ LIN

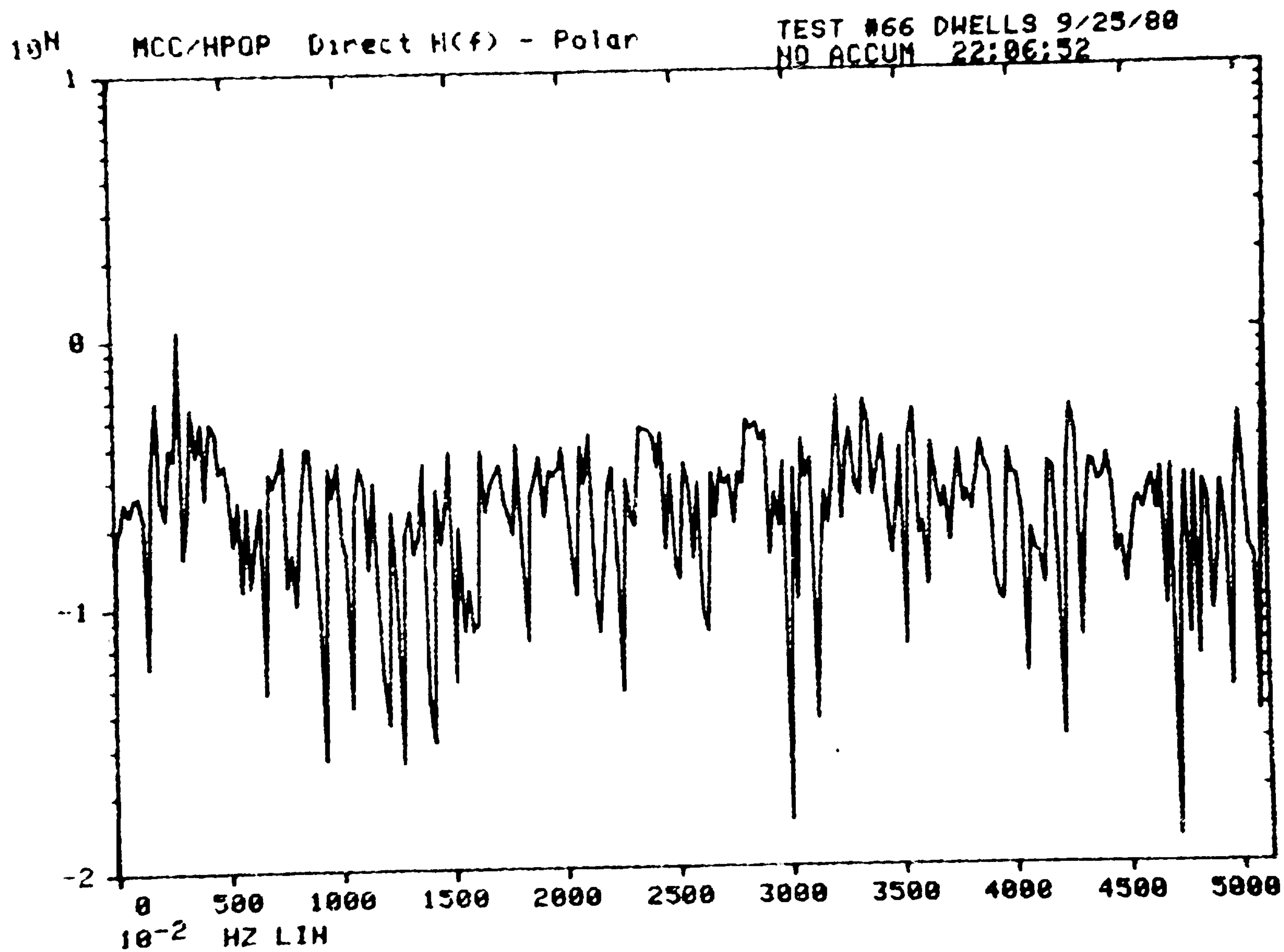
E56



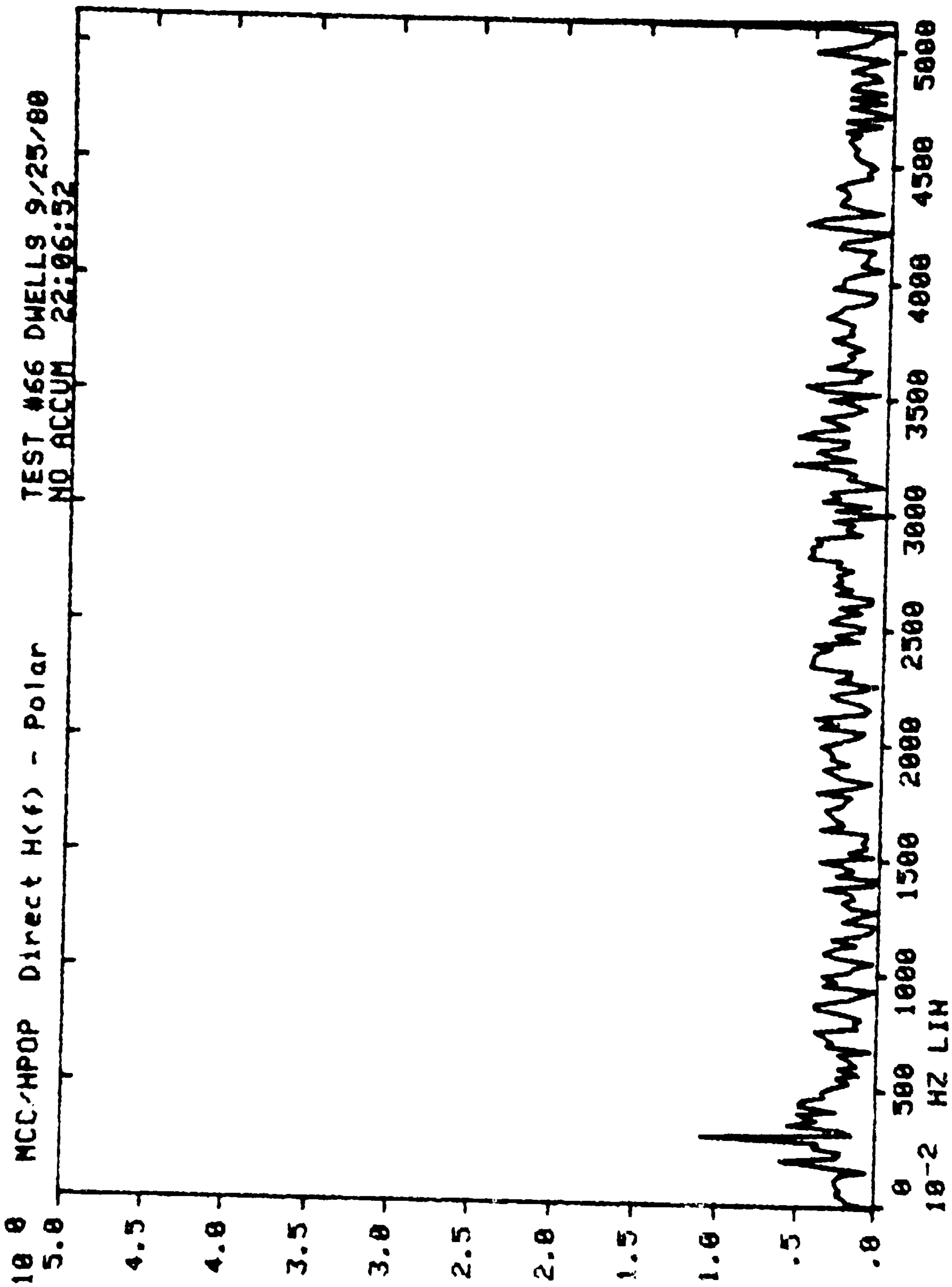
MCC/HPOP Direct H(f)
Pulser Blanked
TEST #66 DWELL, 9/25/80
NO ACCUM 22:06:52
10^N
0
-1
-2
-3
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
10^-2 HZ LIN

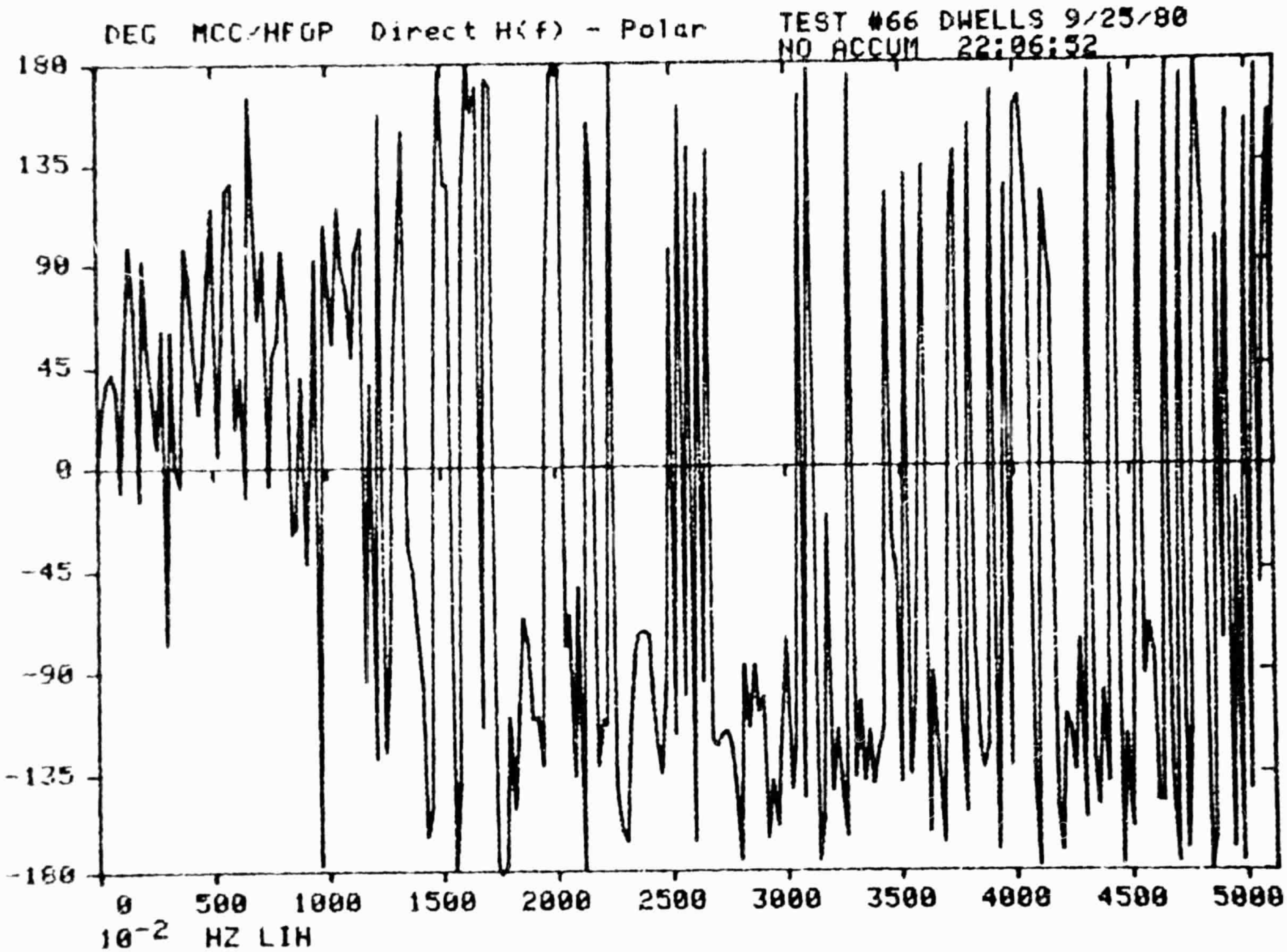

10 0
MCC/HPOP Direct H(f)
Pulser Blanked
TEST #66 DWELLS 9/25/80
NO ACCUM 22:06:52
1.0
.9
.8
.7
.6
.5
.4
.3
.2
.1
.0
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
10-2 HZ LIN


DEG
MCC/HPOP Direct H(f)
Pulser Blanked
TEST #66 DWELLS 9/25/80
NO ACCUM 22:06:52
180
135
90
45
0
-45
-90
-135
-180
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
10^{-2} HZ LIN

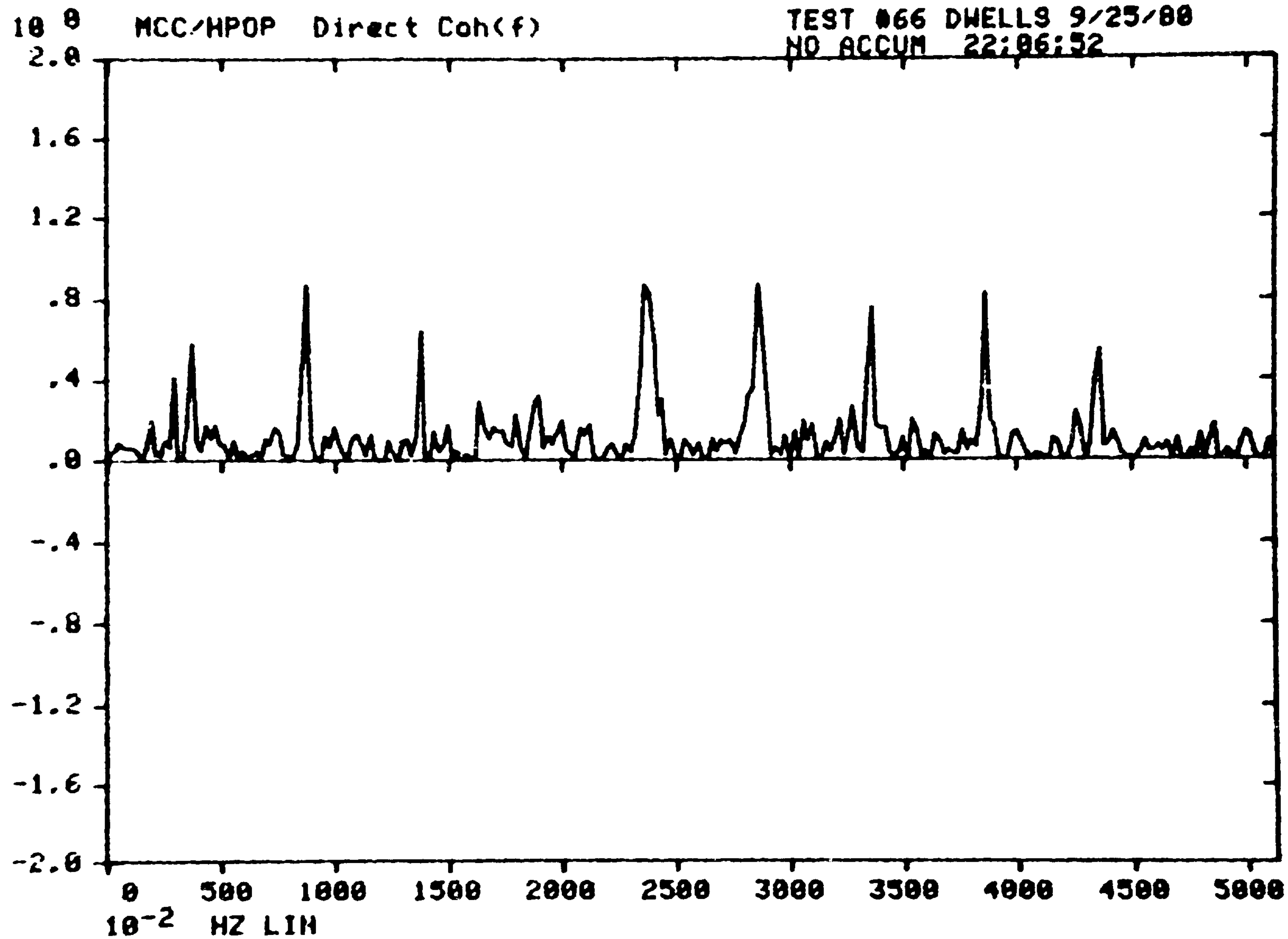

10^N
MCC/HPOP Direct H(f) - Polar
TEST #66 DWELLS 9/25/80
NO ACCUM 22:06:52
1
0
-1
-2
0 500 1000 1500 2000 2500 3000 3500 4000 4500 5000
10^-2 HZ LIN

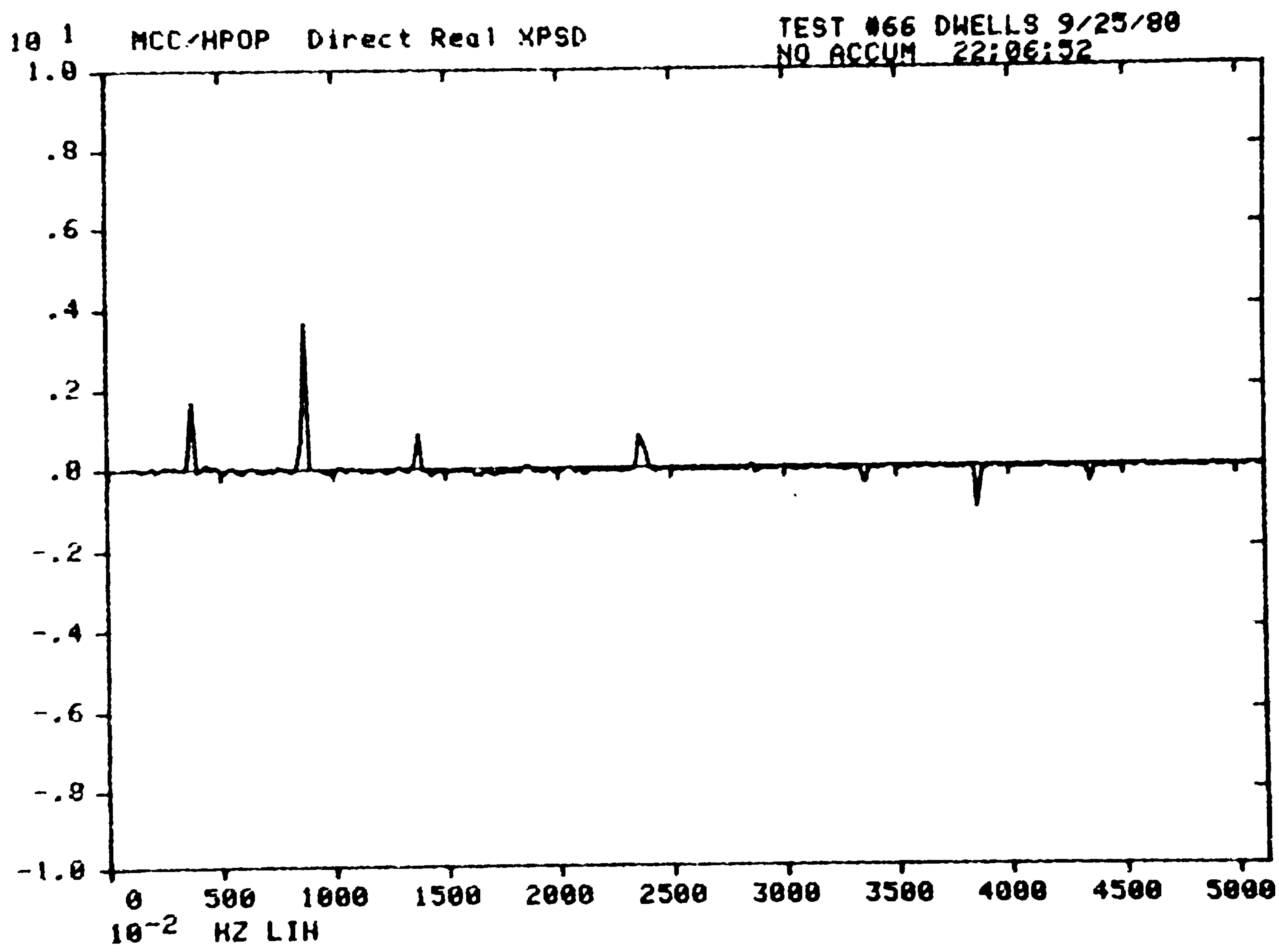
E60

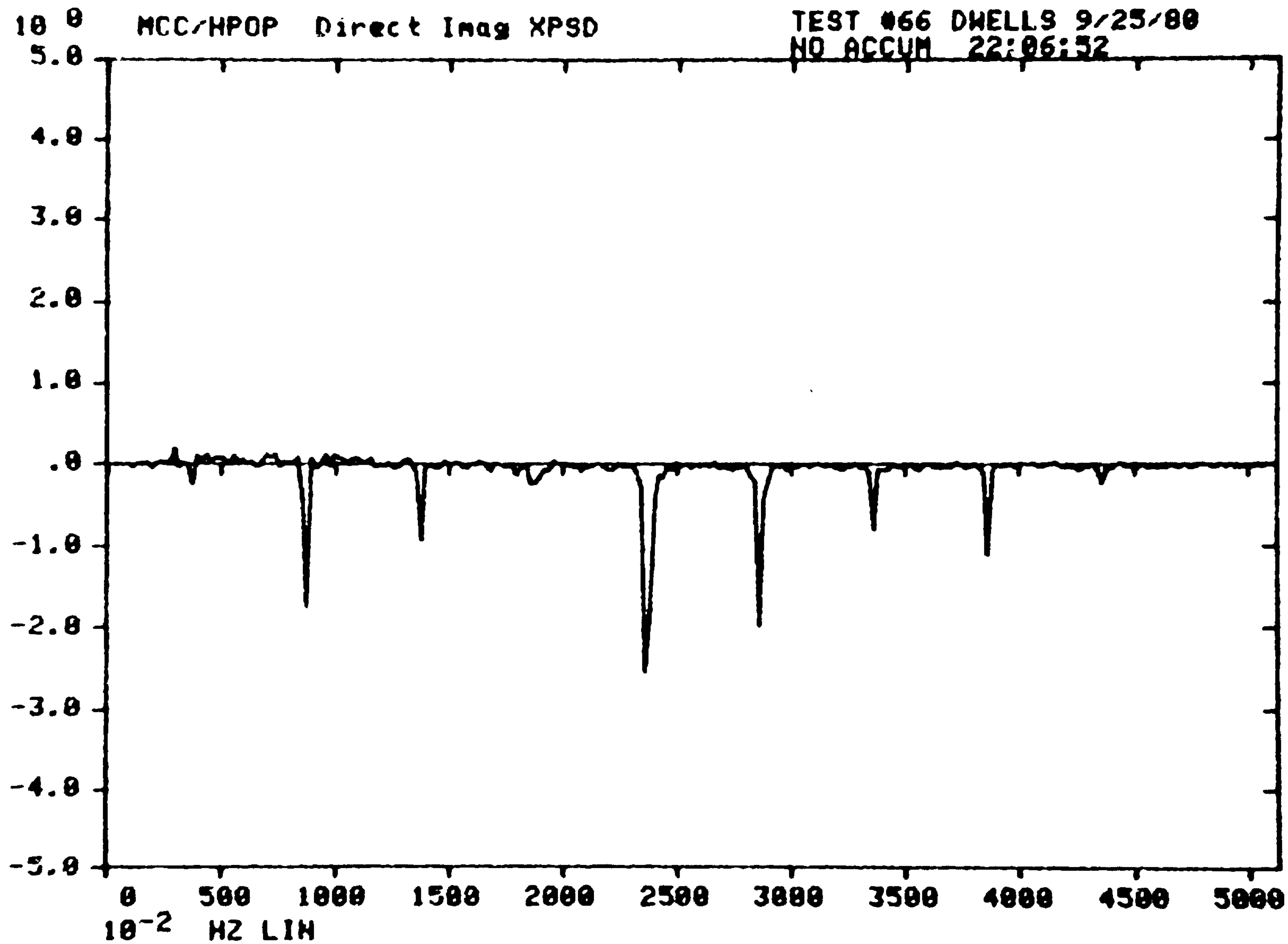

MCC/HPOP Direct H(f) - Polar
TEST #66 DWELLS 9/25/80
NO ACCUM 22:06:52
10 0
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
.5
.0
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
10^-2 HZ LIN

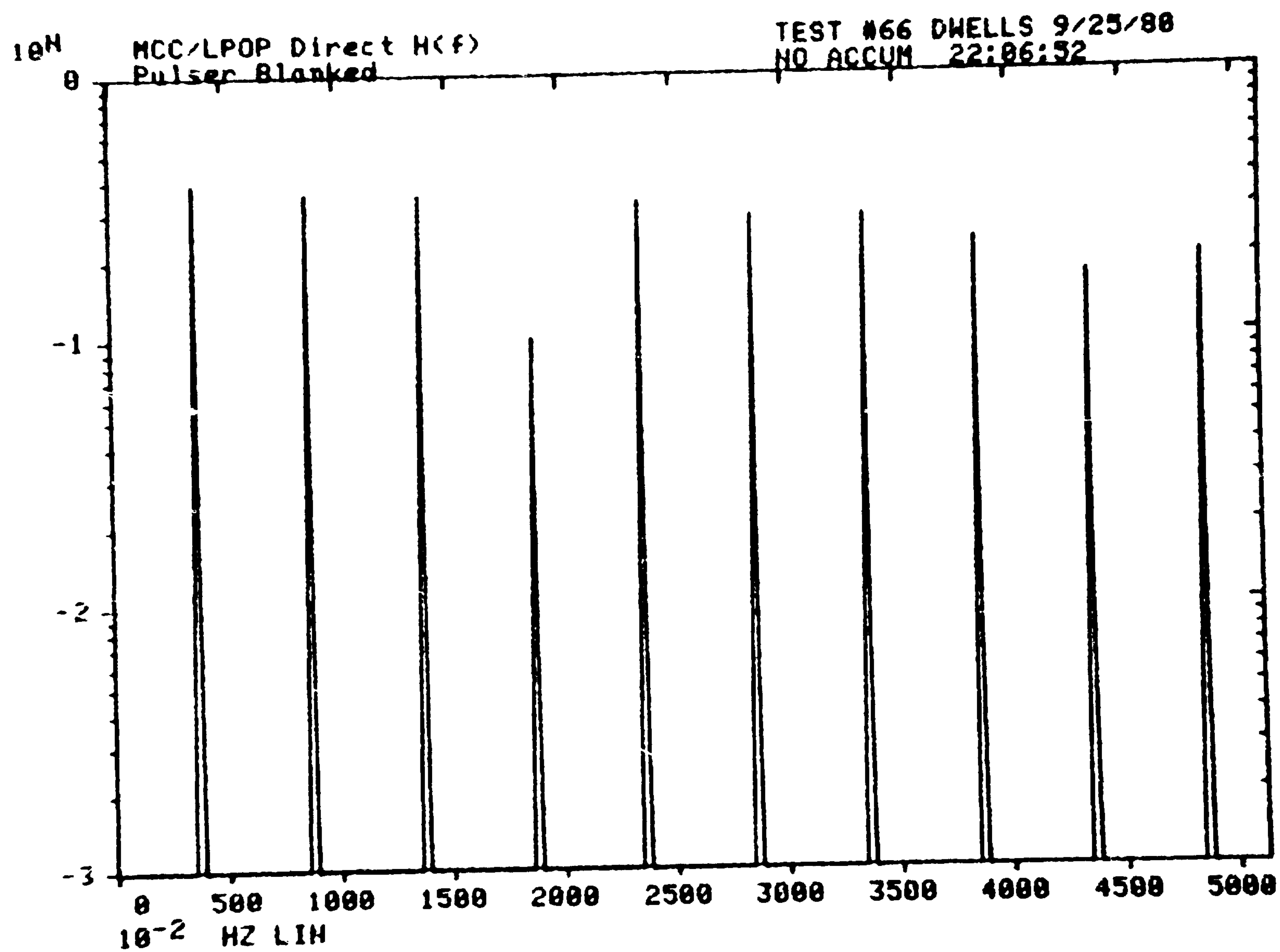

DEG MCC/HFGP Direct H(f) - Polar
TEST #66 DWELLS 9/25/80
NO ACCUM 22:06:52
180
135
90
45
0
-45
-90
-135
-180
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
10^-2 HZ LIH

E61


10 0
MCC/HPOP Direct Coh(f)
TEST #66 DWELLS 9/25/80
NO ACCUM 22:06:52
2.0
1.6
1.2
.8
.4
.0
-.4
-.8
-1.2
-1.6
-2.0
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
10^-2 HZ LIN


10 1
MCC/HPOP Direct Real XPSD
TEST #66 DWELLS 9/25/80
NO ACCUM 22:06:52
1.0
.8
.6
.4
.2
.0
-.2
-.4
-.6
-.8
-1.0
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
10^-2 HZ LIN

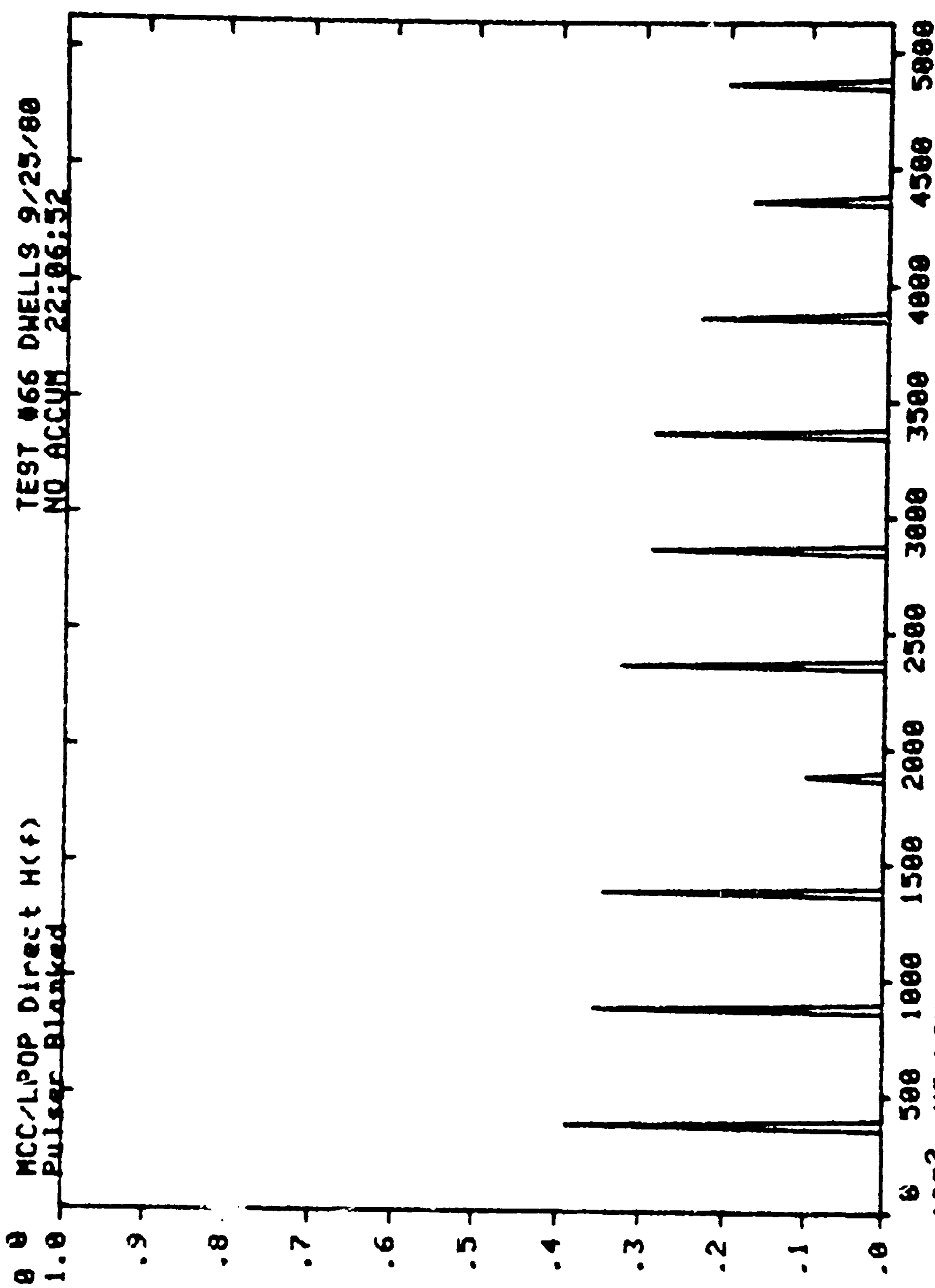

10 0
MCC/HPOP Direct Imag XPSD
TEST #66 DWELLS 9/25/80
NO ACCUM 22:06:52
5.0
4.0
3.0
2.0
1.0
.0
-1.0
-2.0
-3.0
-4.0
-5.0
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
10^-2 HZ LIN

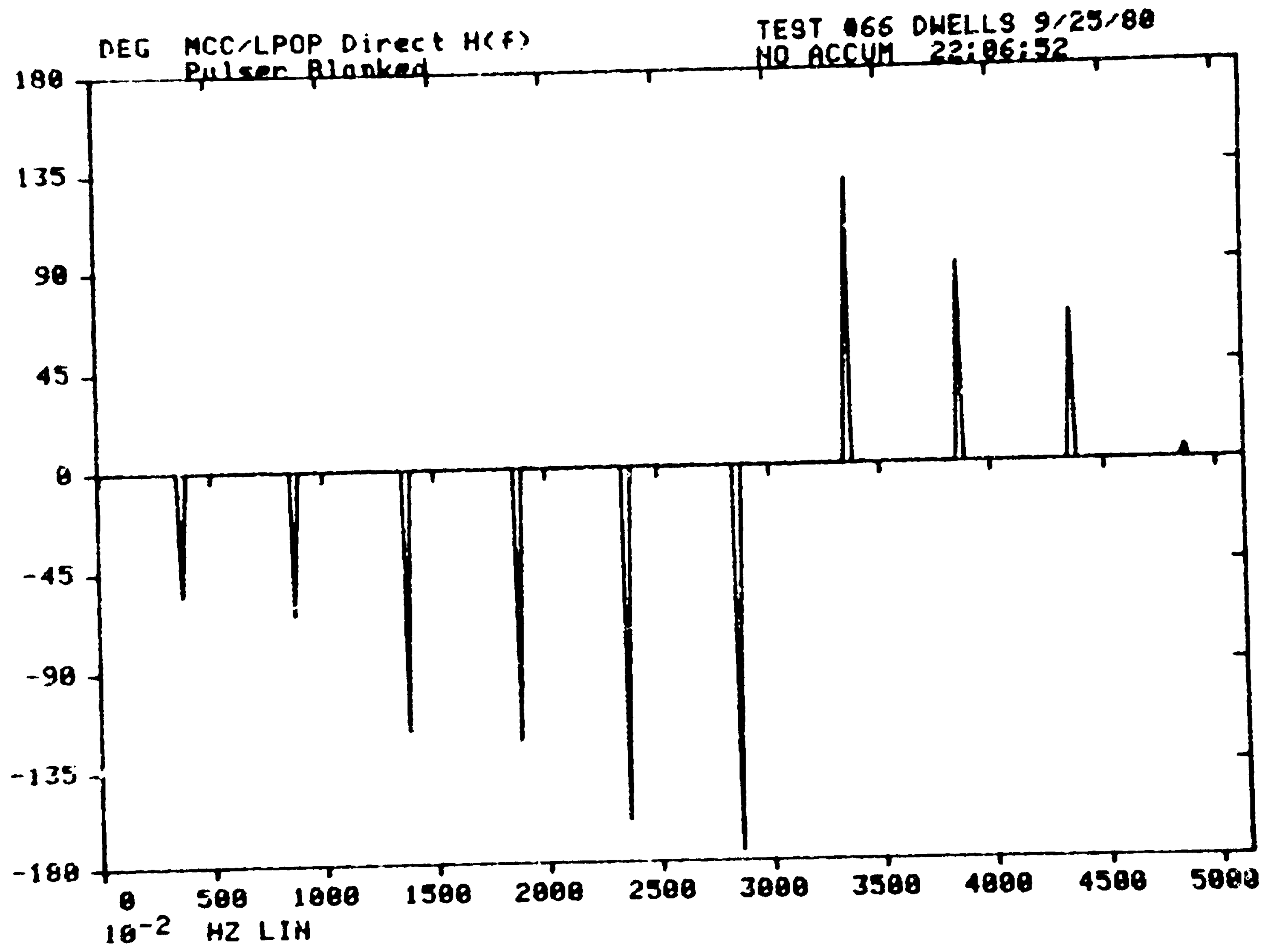


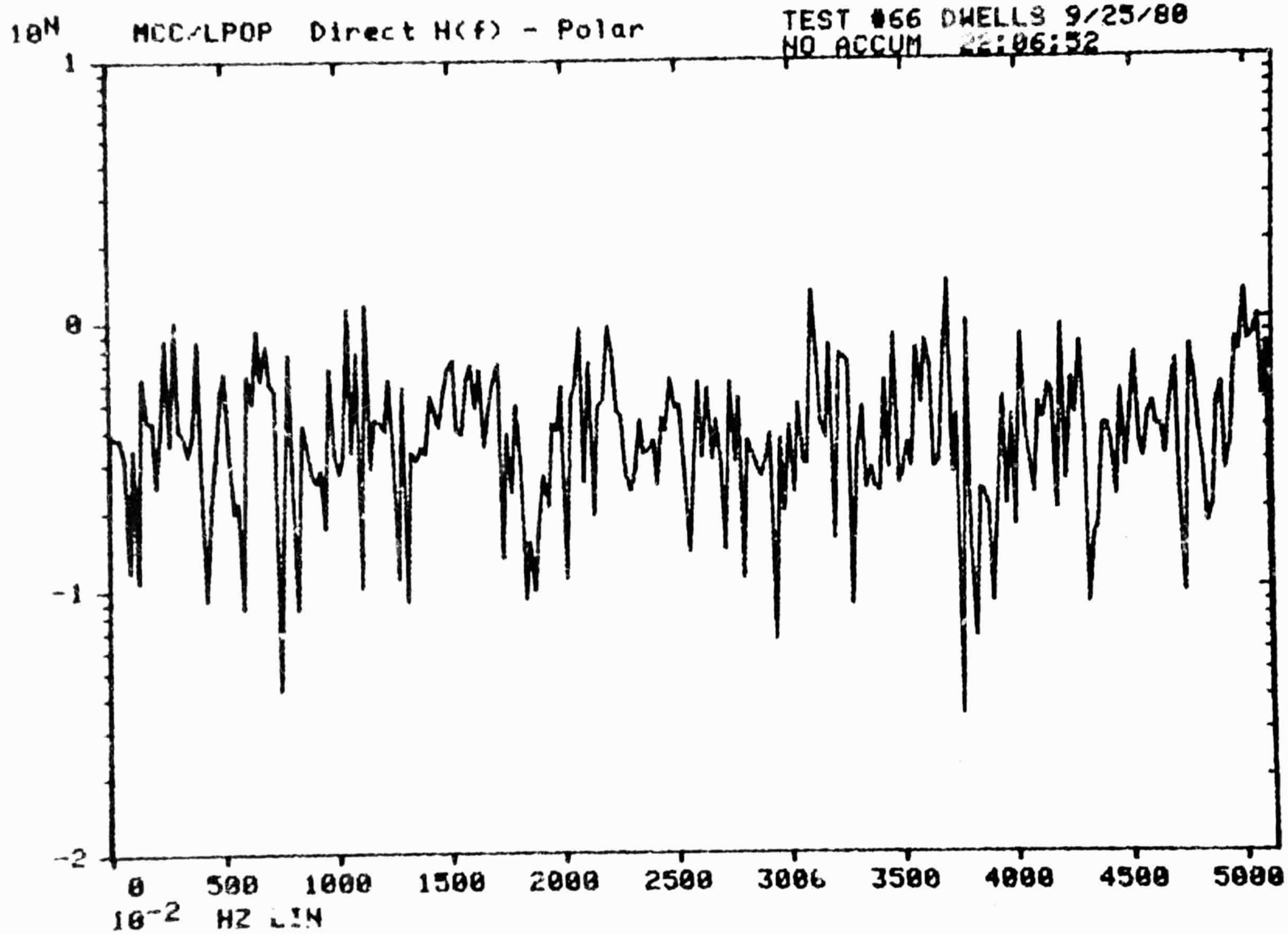
10^N
MCC/LPOP Direct H(f)
Pulser Blanked
TEST #66 DWELLS 9/25/80
NO ACCUM 22:06:52
0
-1
-2
-3
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
10^-2 HZ LIN

E65

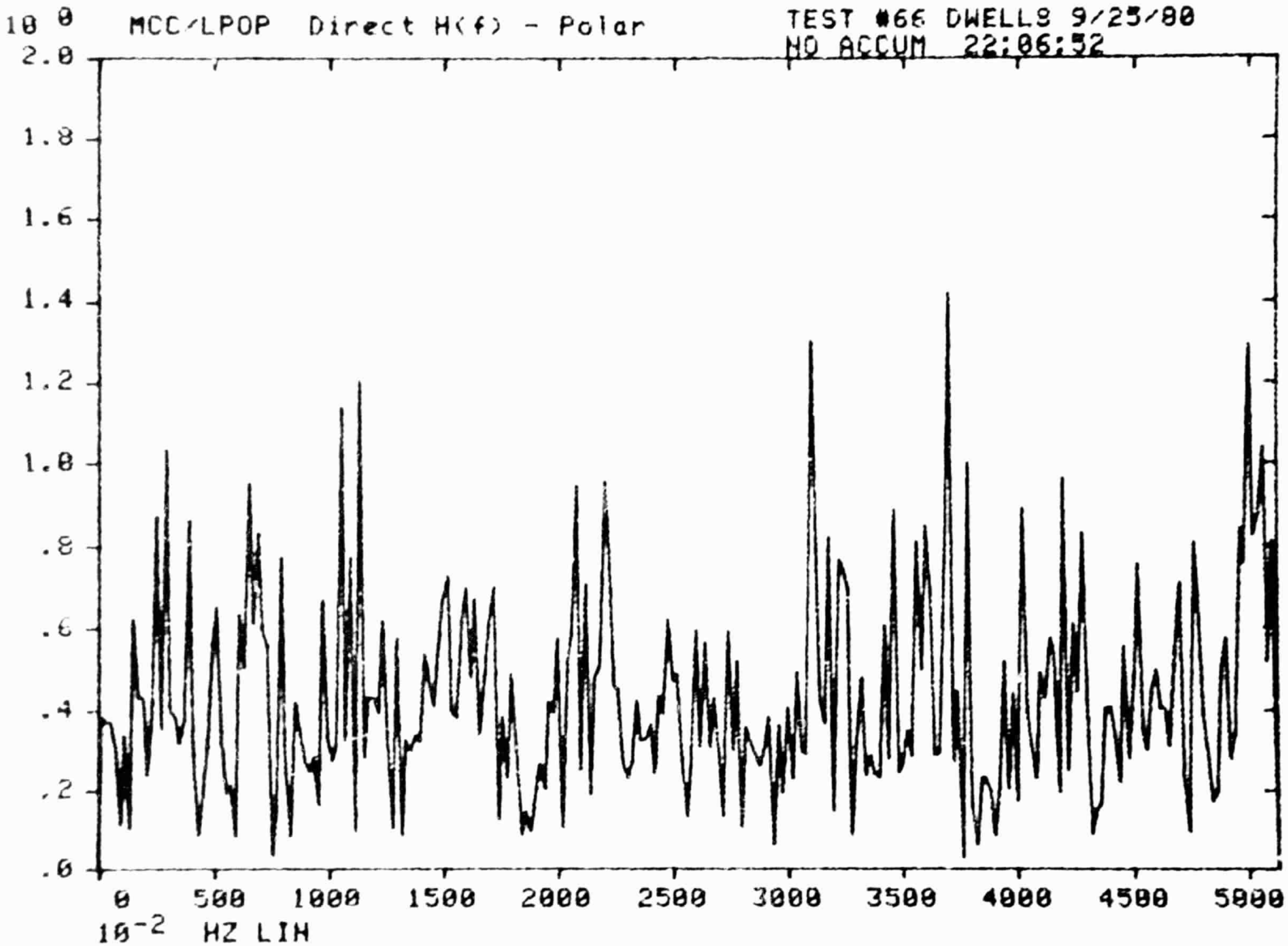
E66

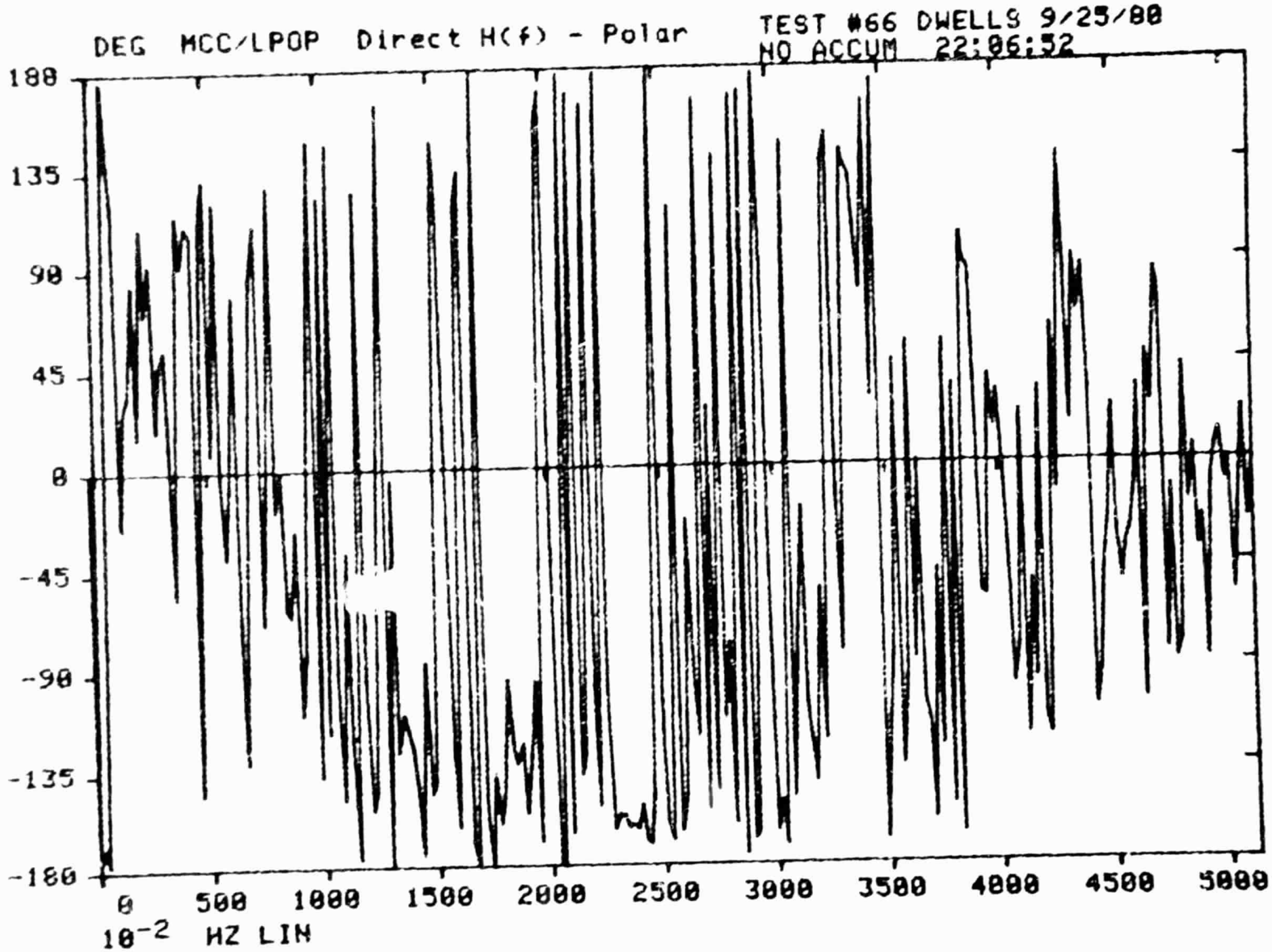

MCC/LPOP Direct H(f)
Pulser Blanked
TEST #66 DWELLS 9/25/80
NO ACCUM 22:06:52
1.0
.9
.8
.7
.6
.5
.4
.3
.2
.1
.0
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
10^-2 HZ LIN

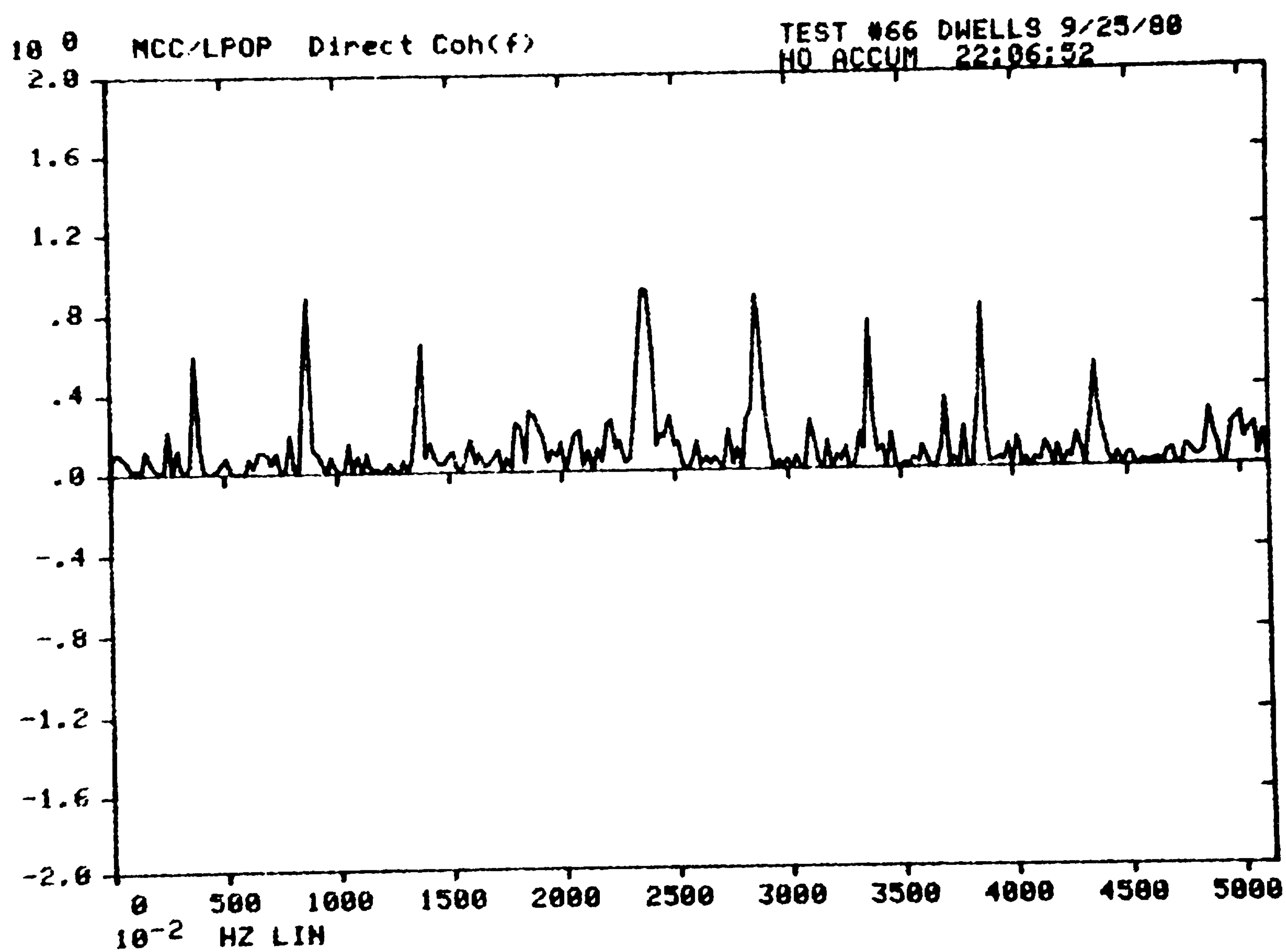

DEG MCC/LPOP Direct H(f)
Pulser Blanked
TEST #66 DWELLS 9/25/80
NO ACCUM 22:06:52
180
135
90
45
0
-45
-90
-135
-180
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
10^-2 HZ LIN



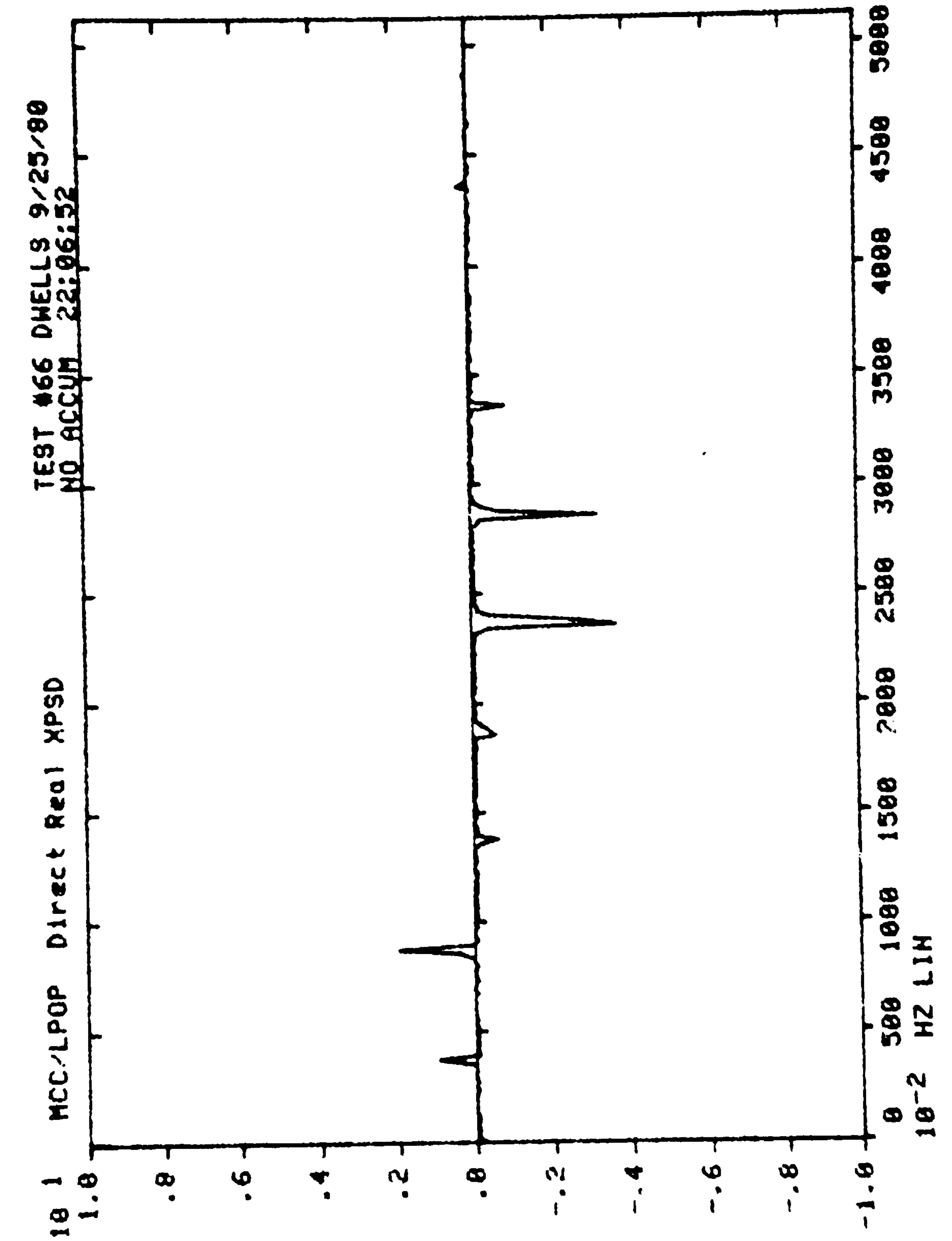
MCC/LPOP Direct H(f) - Polar
TEST #66 DWELLS 9/25/80
NO ACCUM
10^N
1
0
-1
-2
0
500
1000
1500
2000
2500
3006
3500
4000
4500
5000
10^-2 HZ LIN


10 0
MCC/LPOP Direct H(f) - Polar
TEST #66 DWELLS 9/25/80
NO ACCUM 22:06:52
2.0
1.8
1.6
1.4
1.2
1.0
.8
.6
.4
.2
.0
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
10^-2 HZ LIN

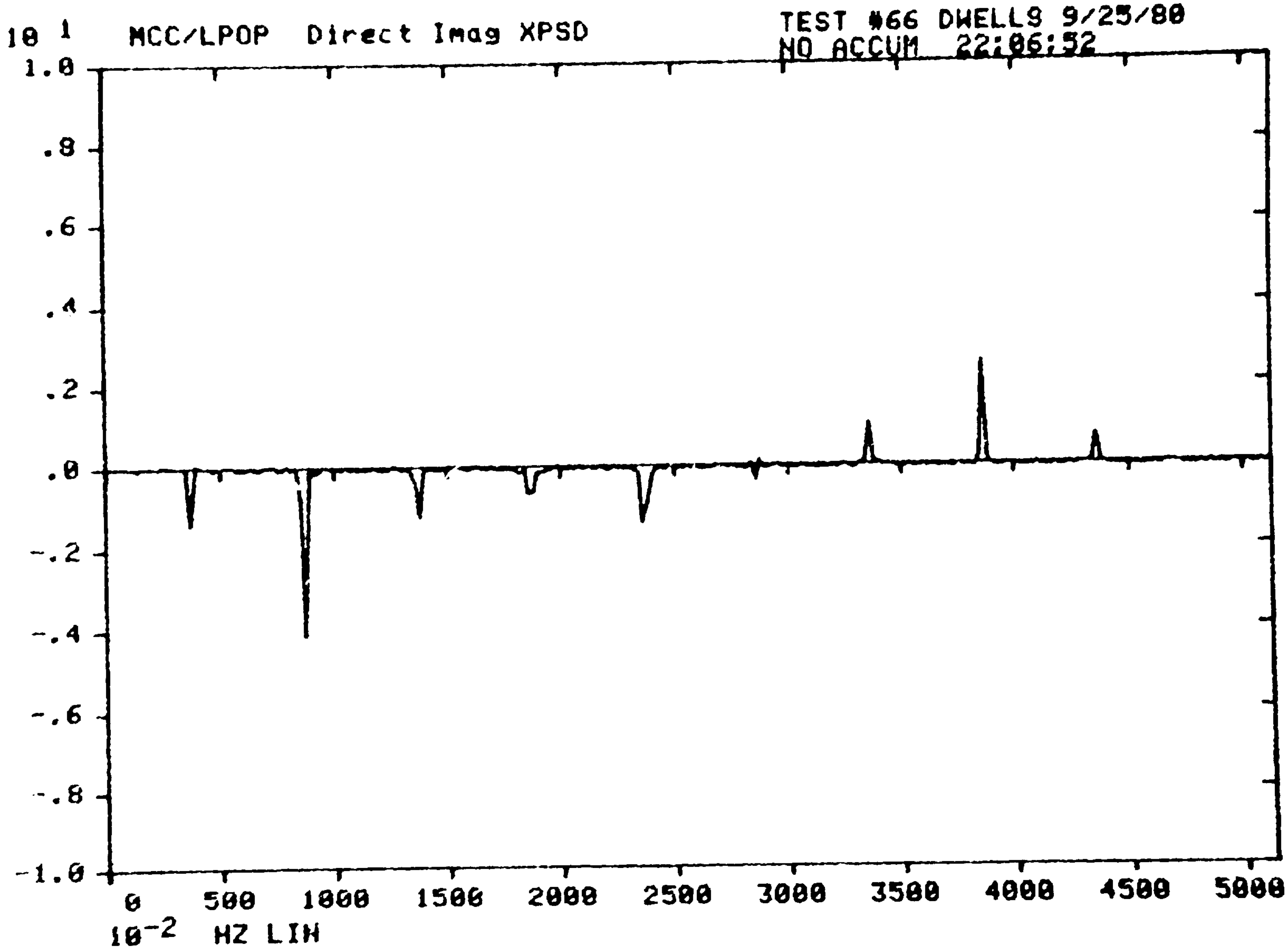

DEG MCC/LPOP Direct H(f) - Polar
TEST #66 DWELLS 9/25/80
NO ACCUM 22:06:52
180
135
90
45
0
-45
-90
-135
-180
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
10^{-2} HZ LIN



10 0
MCC/LPOP Direct Coh(f)
TEST #66 DWELLS 9/25/80
HO ACCUM 22:06:52
2.0
1.6
1.2
.8
.4
.0
-.4
-.8
-1.2
-1.6
-2.0
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
10^-2 HZ LIN



MCC/LPOP Direct Real XPSD
TEST #66 DWELLS 9/25/80
NO ACCUM 22:06:52
10 1
1.0
.8
.6
.4
.2
.0
-.2
-.4
-.6
-.8
-1.0
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
10^-2 HZ LIN



10 1
MCC/LPOP Direct Imag XPSD
TEST #66 DWELL9 9/25/80
NO ACCUM 22:06:52
1.0
.8
.6
.4
.2
.0
-.2
-.4
-.6
-.8
-1.0
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
10^-2 HZ LIN

E73