REPORT ON THE LUNAR SURFACE GRAVIMETER

October 10, 1974

J. Larson and J. Weber, University of Maryland

1. Present Operating Status

The LSG has been operating satisfactorily since thermal control was recovered after a failure of unknown origin during the period 15 March-20 April, 1974.

The present operation may be understood from Figure 1. The mass spring lever system shown is kept balanced by a 140 milligram additional force exerted by the caging mechanism. Present estimates of its sensitivity relative to other Lunar Surface instruments are shown as Figure 2. Only the very sharp resonance region in the vicinity of 1.5 Hertz has been checked by measurements on the emplaced instrument. Within this narrow resonance the LSG is the most sensitive vertical axis accelerometer on the lunar surface. There is evidence, to be presented, that the free modes band sensitivity (one cycle every 20 minutes to one cycle per minute) is considerably better than implied by the RESONANT FREQUENCY OF Figure 2.

2. Highlights of Scientific Results during the Past Year.

The required computing facilities were provided for this experiment in February 1974 by purchase of a PDP 11 computer. Most of the past seven months have been spent writing and debugging programs for decommutation, filtering, display, and power spectrum analysis.

Figure 3 is a photograph of an oscilloscope display of the seismic output for the band 0 to 26 HZ during the first 20 seconds associated with a moonquake at 0050 GMT on 11 July, 1974. The top trace is the filtered real time response and the bottom trace is the power spectrum analysis of the raw data. Clearly the arrival time can be measured with good precision.

Figure 4 is a photograph of an oscilloscope display of low pass filtered seismic data. The raw data was filtered digitally with a cutoff frequency of 2.5 HZ and the data decimated. The time interval shown is approximately 6 minutes and the frequency band of the power spectral density is 2.65 HZ.

Figure 5 is a photograph of an oscilloscope display of the very low frequency (1 cycle/20 min to 3 cycle/min) free modes band output for the 20 minute period including the moonquake. Clearly the free modes band is providing useful scientific data.

We also observe deep origin moonquakes, and slides showing these are to be viewed during our presentation.

3.

The LSG does not operate in the mode intended by its designers, and experiments on the emplaced instrument have suggested the present arrangement of levelling and spring adjustments. Observations in the seismic band, by applying known forces, have measured the sensitivity. Attempts have been made to operate closed loop, for the purpose of obtaining tidal data.

Some data were obtained, but there were periods of instability suggesting much higher free modes band sensitivity. The experiments were not continued because of the good quality of open loop data and the risks involved in repeated reconfigurations. New attempts would be in order if review of processed data appears to justify it.

4.

It is recommended that the present operations and support levels be continued until the next review. By that time we will have employed the present computer programs to process a considerable portion of our backlog of tapes to carry out a number of investigations.

a) We have earth based gravitational radiation detectors at Maryland and near Chicago which have been recording coincident changes in power. Another group at the Max Planck Institute in Munich has been obtaining somewhat similar results, and we are exchanging tapes with them. We plan to study the Lunar Surface acceleration to search for correlations with these data.

b) We will search for sharp spectral peaks within the resonance band at 1.5 Hertz which might be associated with pulsar gravitational radiation.

c) We will continue search for excitation of the lunar surface in the very low frequency free modes band, for evidence of lunar free oscillations.

d) We will search for evidence of correlation of lunar surface acceleration with the gamma ray bursts of the Vela satellites.

We believe that observations of the response of the LSG to lunar surface excitation or to excitation produced by commands is the best way to establish its sensitivity. We will extend the measurements already made in the seismic band to the free modes band by continued study of moonquake response.

5.

The search for correlations with other experiments, and the availability of already written programs for data analyses make continuation of the present principal investigator appropriate.

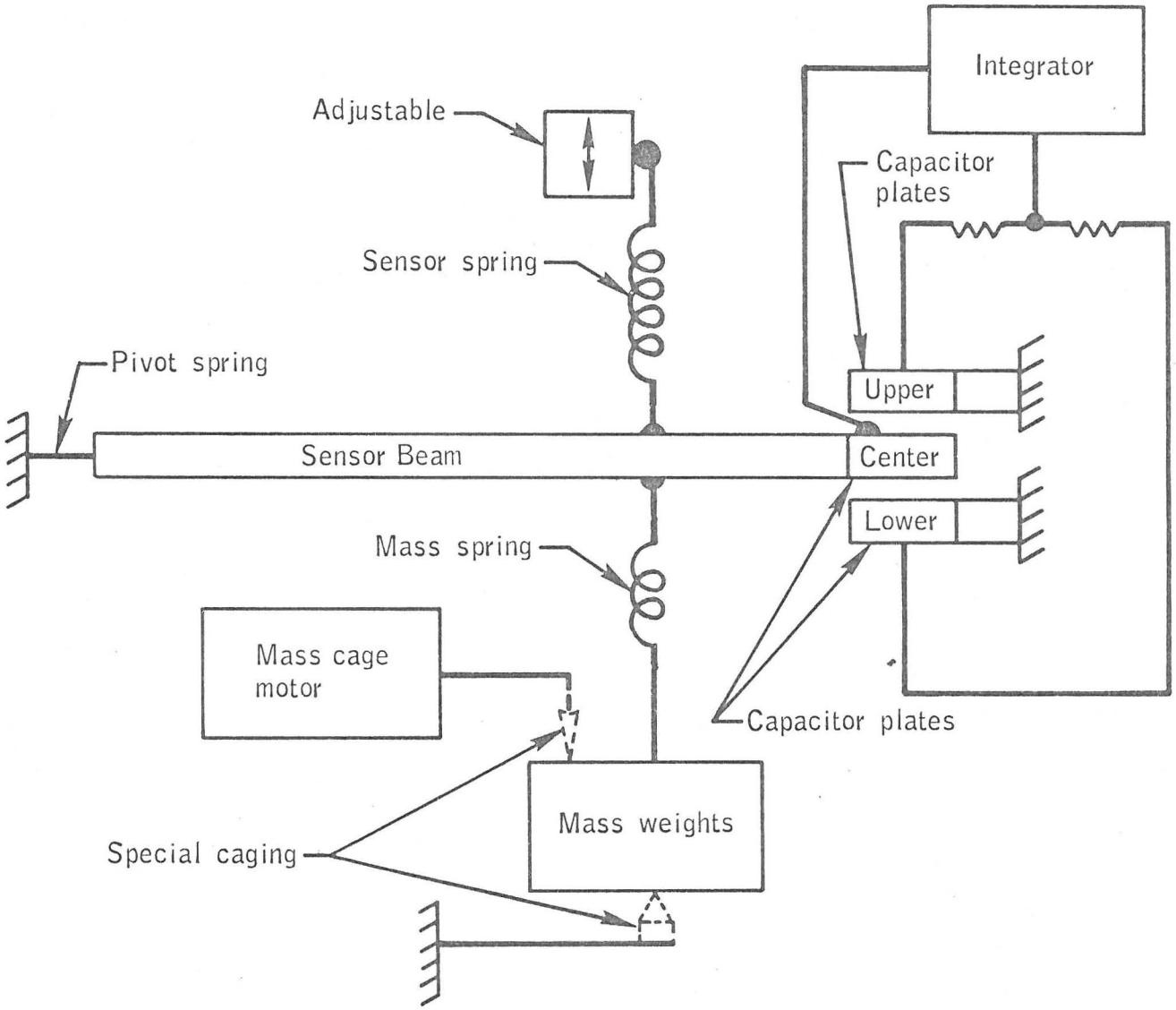


Figure 5-1.- Lunar surface gravimeter sensor beam centering.

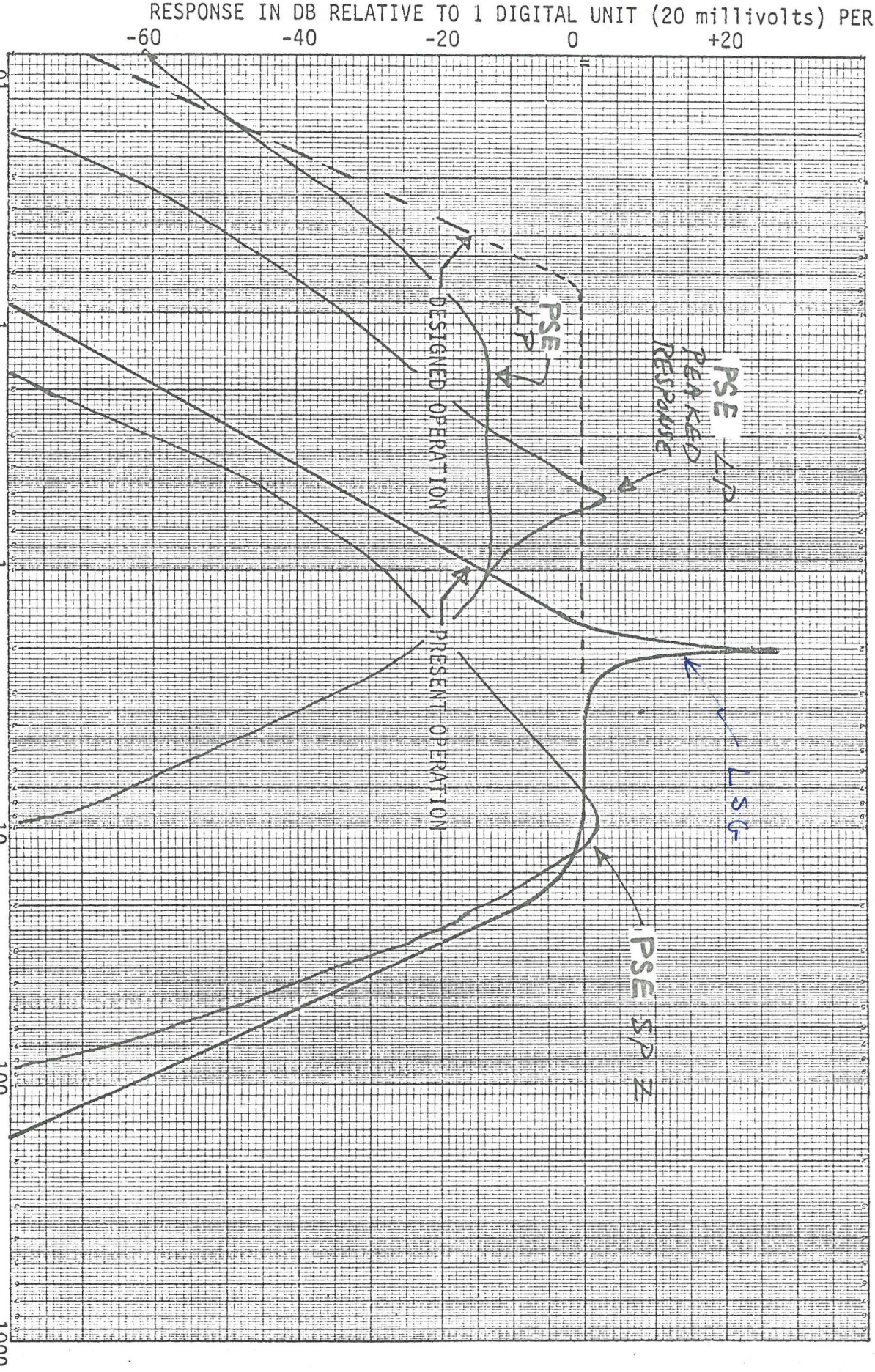
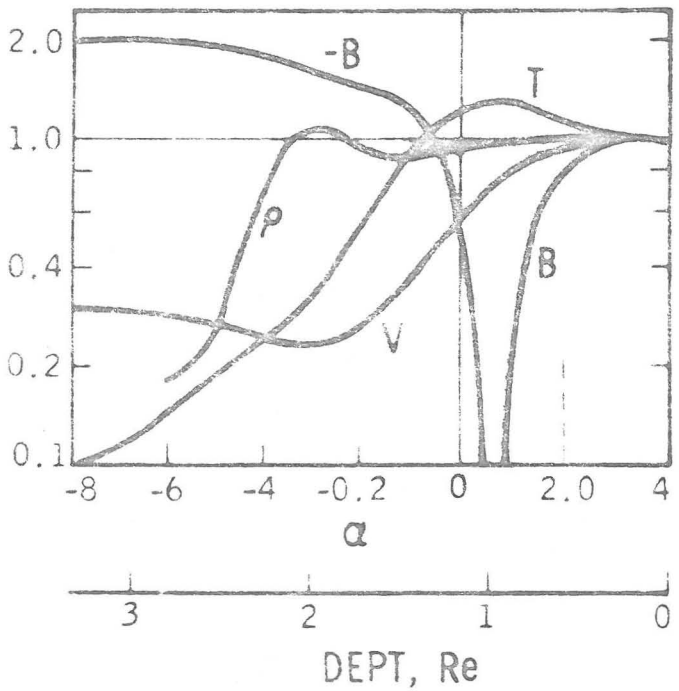
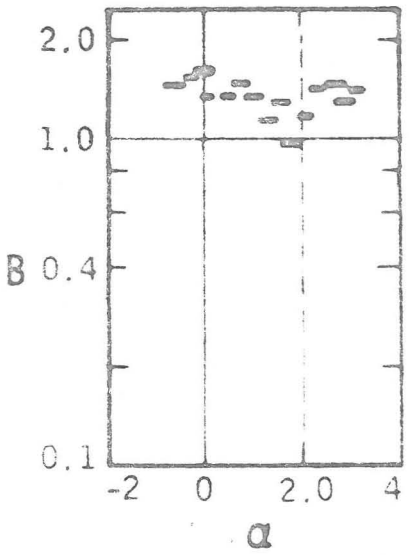
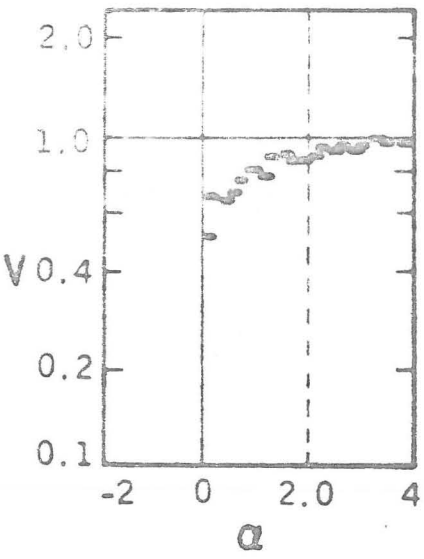
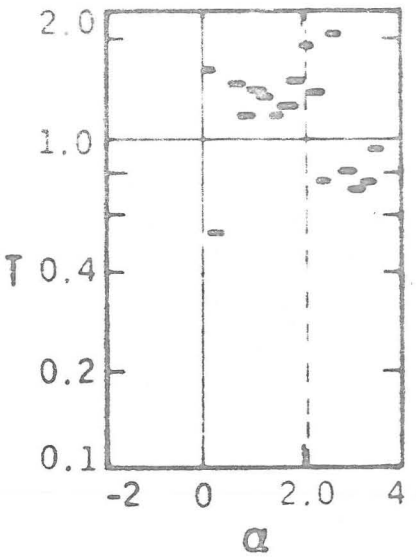


FIGURE 5. SEISMIC RESPONSE CURVES IN THE HIGH GAIN SEISMIC MODE


2.0
1.0
0.4
0.2
0.1
-B
T
ρ
B
V
-8
-6
-4
-0.2
0
2.0
4
α
3
2
1
0
DEPT, Re


2.0
1.0
B 0.4
0.1
-2
0
2.0
4
α


2.0
1.0
V 0.4
0.2
0.1
-2
0
2.0
4
α


2.0
1.0
T 0.4
0.2
0.1
-2
0
2.0
4
α

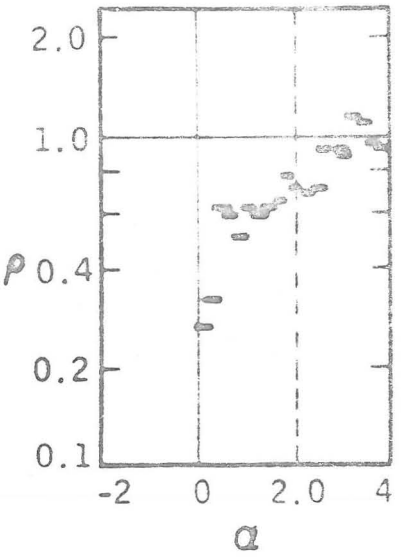

2.0
1.0
ρ 0.4
0.2
0.1
-2
0
2.0
4
α

Fig (6)

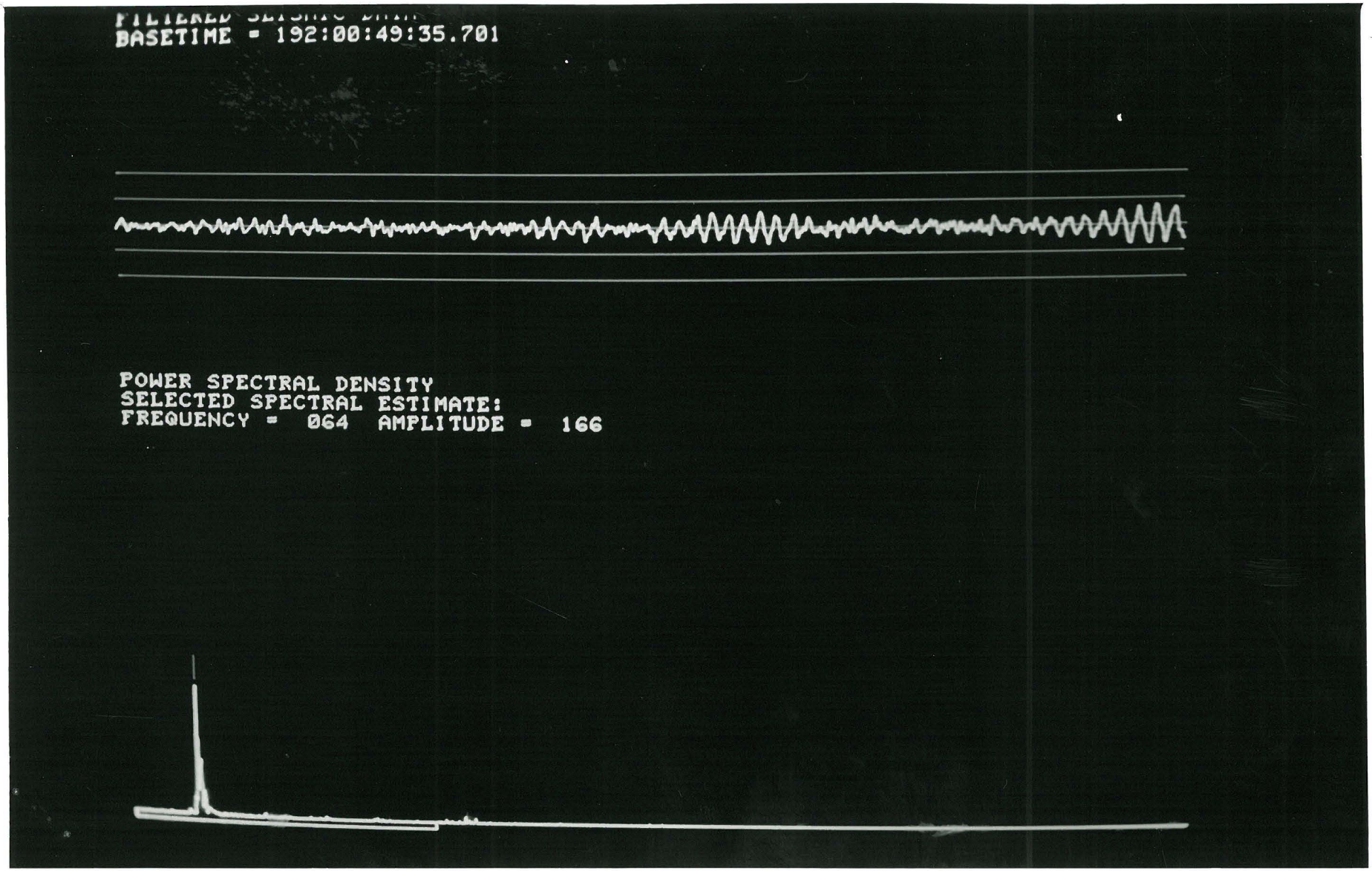

BASETIME = 192:00:49:35.701
POWER SPECTRAL DENSITY
SELECTED SPECTRAL ESTIMATE:
FREQUENCY = 064 AMPLITUDE = 166

FIGURE 3

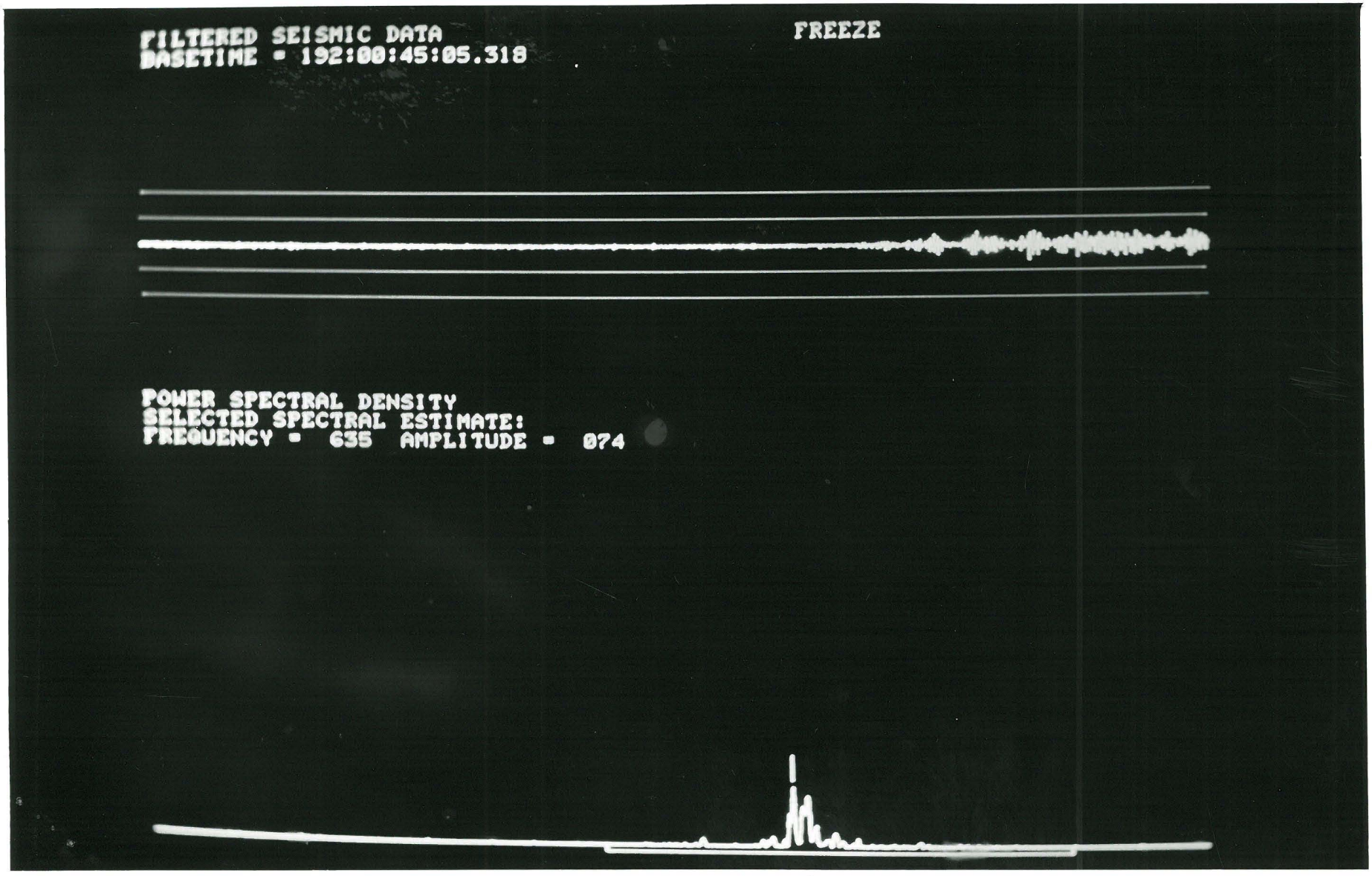

FILTERED SEISMIC DATA
BASETIME = 192:00:45:05.318
FREEZE
POWER SPECTRAL DENSITY
SELECTED SPECTRAL ESTIMATE:
FREQUENCY = 635 AMPLITUDE = 074

FIGURE 4

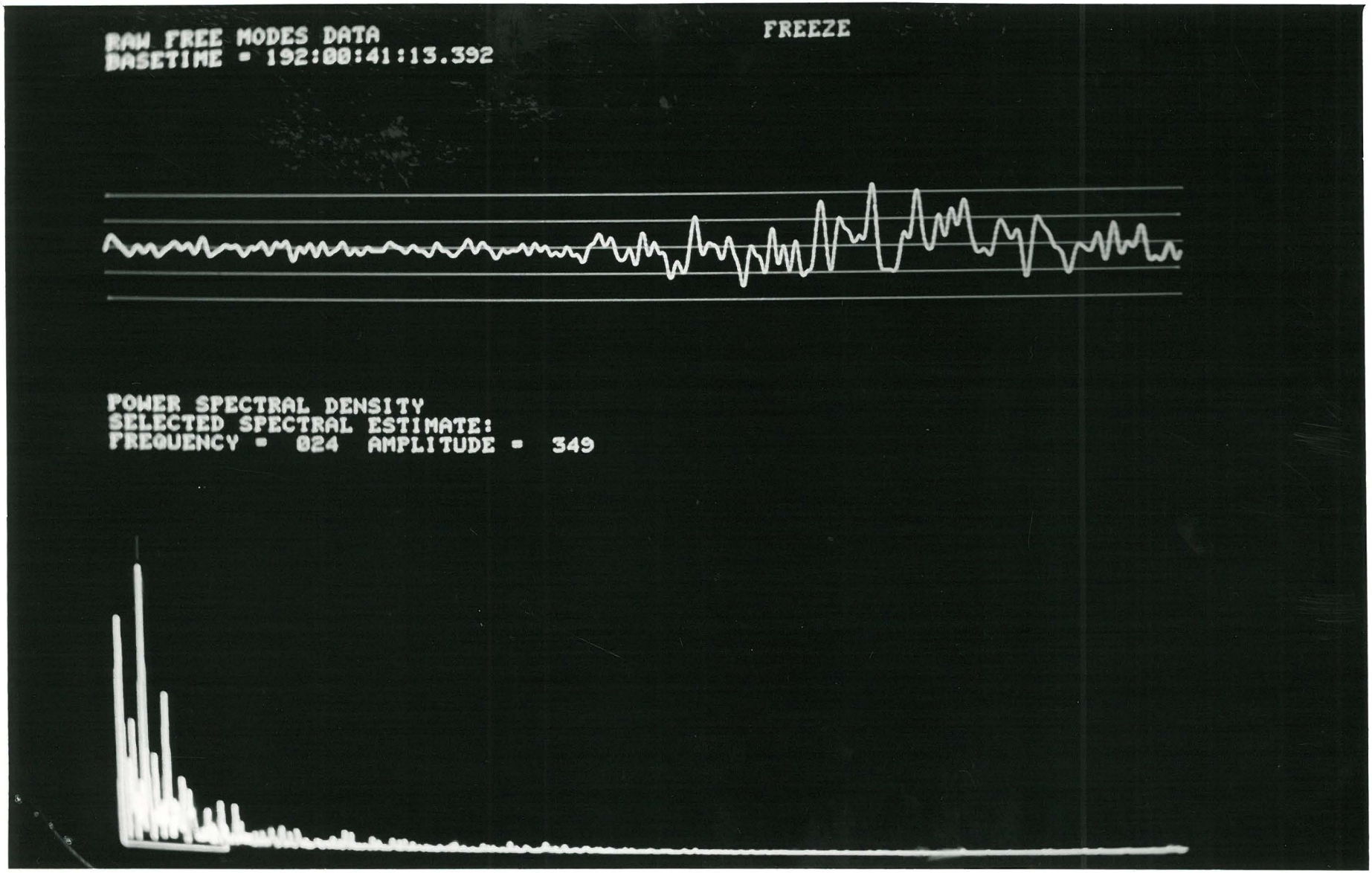

RAW FREE MODES DATA
BASETIME = 192:00:41:13.392
FREEZE
POWER SPECTRAL DENSITY
SELECTED SPECTRAL ESTIMATE:
FREQUENCY = 024 AMPLITUDE = 349

FIGURE 5