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Record 1975/2

THE EFFECTS OF FINITE MAGNETOMETER BANDWIDTH ON A POINT SOURCE AEROMAGNETIC ANOMALY

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CONTENTS

SUMMARY

This investigation was carried out so that design parameters for magnetometers could be precisely defined both for the equipment designer and the user. The parameters looked at in detail were bandwidth, slew rate, and digital sampling rate. Magnetometer bandwidth and slew rate are rarely mentioned in manufacturers' literature. Bandwidth may be traded off in order to obtain seemingly improved noise performance; bandwidth however has an important effect on the shape of a recorded aeromagnetic anomaly and should be considered in the specifications for any aeromagnetic work.

The following conclusions have emerged from the investigation:

(1) Airborne magnetometers with a third-order or higher bandwidth characteristic must have a bandwidth of at least 1 Hz.

(2) Magnetometer slew rate should be at least 5000 nT/s, regardless of magnetometer bandwidth, if the error from this source ($\leqslant$900 nT) is to be kept less than the error due to uncertainty of aircraft position for the case considered.

(3) A digital sampling rate of 1 per second is more than adequate to specify a 'worst caste' anomaly of 13 000 nT to better than 0.4 nT accuracy at any point with the RMS error of less than 0.05 nT over the whole anomaly.

The assumptions used in coming to the above conclusions were as follows:

(a) Aircraft height and velocity of 150 m and 50 m/s respectively.

(b) Aircraft and anomaly positional accuracy of $\pm$ 10 m.

(c) Total field of 58 000 nT with a point source magnetic anomaly peaking at 71 000 nT. Angle of dip was (π/2 - 0.5) rad.

(d) Anomaly peak amplitude error (compensating for peak position) of $\pm$ 70 nT.

(e) A point source magnetic anomaly with a maximum of 13 000 nT at a detector height of 150 m.

The conclusions drawn in this record apply to any magnetometer (fluxgate, alkali vapour, proton, induction, mechanical, etc.) with a lowpass response of order three or higher.

1. INTRODUCTION AND BASIC THEORY

1.1 The author carried out the investigation contained in this Record while engaged on the design of a high-performance airborne fluxgate magnetometer (MFS7) in the Electronic Design and Development Laboratories at BMR. The investigation was carried out so that design parameters for magnetometers could be precisely defined both for the equipment designer and the user. The parameters considered in detail were bandwidth, slew rate, and digital sampling rate. Bandwidth is the band of frequencies over which an associated amplitude response is within $\pm$ 30 percent of its nominal mid-band value. Slew rate is the rate of change of some variable with respect to time; in this Record, slew rate will always be taken as referring to rate of change of magnetometer output, expressed as nT/s.

1.2 Magnetometer bandwidth and slew rate are rarely, if ever, mentioned in manufacturers' literature and it is doubtful if many users understand what is required in this area. Manufacturers often tradeoff bandwidth in order to obtain seemingly improved noise performance. It will be seen that magnetometer bandwidth (as well as bandpass shape) has an important effect on the shape of a recorded aeromagnetic anomaly, and should be considered in the specification for any aeromagnetic work.

1.3 Airborne magnetometers inherit all the problems of fixed magnetometers as well as being subjected to a limited bandwidth and a changing magnetic field. The changing magnetic field can be considered as an infinite series of frequencies of differing amplitude and phase in the frequency domain. These frequencies will be differently affected in relative magnitude and phase in passing through the magnetometer and ancillary recording equipment, thus affecting the observed magnitude of the time varying field. Even if errors due to finite equipment bandwidth are negligible, they must still be known if one is to have any confidence in the measurements made.

1.4 The techniques described in this Record may be easily applied to any geophysical system which takes measurements in the time domain, providing the system transfer function is known. These techniques will then allow calculation of the true time dependent input from a knowledge of the time varying output (the observed output).

1.5 Most geophysical mechanical or electronic measuring equipment has an input and an output. The system can thus be described by a transfer function:-

$$F(s) := \frac{Eout(s)}{Ein\ (s)} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1.1)$$

in the frequency domain. (:= means 'is defined equal to'). s is the Laplace variable. Equation (1.1) could be written less conveniently in the time domain as

$$f(t) = L^{-1}\ F(s) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1.2)$$

where t is time and L^{-1} is the inverse Laplace transform (generalized inverse Fourier transform).

1.6 If F(s) is known, it is relatively simple to find Ein(s) for any Eout(s) in the frequency domain. However, most geophysical measurements and experiments are carried out in the time domain, necessitating a convolution of f(t) with the inverted e out(t) in order to find e in(t):- the time dependent input. A second approach is to perform the Fourier transform on e out(t) giving Eout(s), then apply F(s) by simple multiplication with the inverse of Eout(s) and then carry out the inverse Fourier transform to find e in(t). This second approach has been used here for two reasons:

(a) It gives interesting information concerning the power spectrum of both input and output. This is of prime importance in the consideration of digital sampling rates.

(b) For a specific input signal, only one forward Fourier transform is required; calculations are simpler than those using the inverse Laplace transform - which could prove to be more economical in different situations.

1.7 The method shown here can be directly applied to many geophysical situations where it is desired to correct or predict a time varying signal emanating from some device whose transfer function in the frequency domain can be discovered.

1.8 In this Record, the abovementioned techniques are applied to a typical specific problem of determining the effects of limited system bandwidth on aeromagnetic anomalies. Aeromagnetic anomalies are simply time dependent outputs from a magnetometer flying through a non-uniform magnetic field. The anomaly chosen here was 'worst case' - i.e. maximum size of about 14 000 nT - with the aircraft flying at a height of 150 m and speed of 50 m m/s. (Normal BMR survey limits).

1.9 In this case, a third-order lowpass system was chosen to represent the magnetometer and various bandwidths applied to the transform of the 'worst case' magnetic anomaly. In each case the inverse transform was then carried out and the 'modified' anomaly compared with the 'input' anomaly. Various conclusions can be drawn about bandwidth commensurate with errors. Before the transform of the anomaly is carried out, it is necessary not only to have a suitable anomaly, but also to know what time intervals, etc. should be used. Sections 2 and 3 deal with this.

1.10 Interpretation of aeromagnetic data usually requires the specification of half-widths, points of inflexion, and half-heights of anomalies. It is necessary that the accuracy of these parameters be specified or that they be corrected for system response before interpretation. In aeromagnetic mapping applications it is desirable that the anomaly be recorded as accurately and faithfully as possible. It will be shown that minimum acceptable bandwidths can be specified for BMR magnetometers and contractors' equipment. Furthermore, the techniques and programs used are quite general and may be applied to different magnetometers or to a variety of other geophysical systems.

1.11 A brief resume is given of Section (1) and the Sections which follow it.

An aeromagnetic anomaly can be represented as a real, time dependent vector function $\tilde{F}(t)$ where $\tilde{F}(t) = \tilde{G} + \tilde{A}(t)$

$\tilde{F}(t)$ is the total vector magnetic field seen by an aircraft flying over the anomaly. $\tilde{G}$ is an assumed time invariant vector field - the regional geomagnetic field. $\tilde{A}(t)$ is the vector field due to the anomaly. In airborne geophysical applications, one generally looks only at the magnitude of the magnetic field or $/\tilde{F}(t)/ = /G + A(t)/$. Subtracting the 'baseline' or $/G/$ gives the magnitude of tha anomalous field B(t).

$$\text{i.e. } B(t) = /F(t)/-/G/ = /G + A(t)/ - /G/ \quad . \; . \; . \; . \; . \; . \qquad (1.3)$$

The Fourier transform of B(t) will give B in the frequency domain, - i.e. $B(\omega)$, where ω is frequency in radians per second. The magnetometer and ancillary recording and acquisition equipment has an associated transfer function F(s) which allows calculation of the input signal in terms of amplitude and phase at different angular frequencies ($\omega = 2\pi f$). (For sinusoidal inputs, $s = j\omega$, where $j = \sqrt{-1}$.) If we pass the transformed anomaly B(w) through a system with transfer function F(jw), then the modified anomaly is given by:-

$$Bm(\omega) = F(j\omega).\ B(\omega) \quad . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \qquad (1.4)$$

The inverse Fourier transform of $Bm(\omega)$ can then be carried out to find Bm(t), the modified anomaly in the time domain. A comparison of Bm (t) with B(t) will then show the error introduced into the recording of the anomaly by the magnetometer.

2. MAGNETIC ANOMALY EQUATION AND TRANSFORM CONSIDERATIONS

2.1 A magnetic field due to a point magnetic source falls off less rapidly with distance than dipole fields. However a point magnetic rather than a dipole source was chosen for the determination of a 'worst case' magnetic anomaly. We consider here the two-dimensional case. (Note that in reality, monopoles do not exist and can only be approximated.) A dipole source was not used owing to the problem of deciding on a suitable dipole distance.

2.2 Consider an aircraft flying at constant height (h) and velocity (v) over a point source of magnetic intensity (m). Let the inclination of the Earth's field be $(\pi/2 - \theta)$. Let the constant geomagnetic field be $\tilde{G}$.

$$\text{then } \tilde{A}(t) = \frac{km}{(d(t))^2} \cdot \tilde{1}d \quad \ldots\ldots\ldots\ldots \quad (2.1)$$

where k is a constant and $\tilde{A}(t)$ the time dependent field.

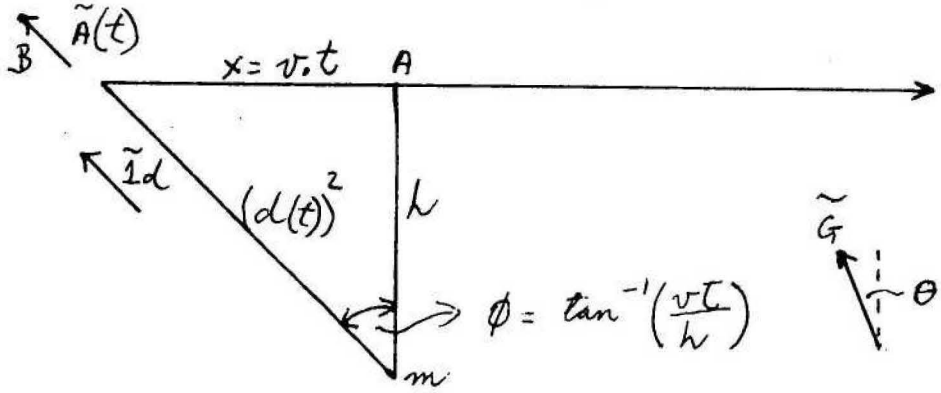

Figure (2.2a)

at point A, let t = 0 and then d(t) = h

$$\text{thus } \tilde{A}(t) = \frac{h^2 A_0(h)}{(v^2t^2+h^2)} \cdot \tilde{1}d \qquad \text{(point B)} \quad \ldots\ldots\ldots\ldots \quad (2.2)$$

where $\tilde{1}d$ is a unit vector in the d direction,

and $Ao(h) := \frac{km}{h^2}$

Now, $\tilde{A}(t)$ is at $\tan^{-1}\left(\frac{vt}{h}\right)$ to the vertical;

thus, the total time dependent field amplitude at point B is given by

$$/\tilde{F}(t)/ = /\tilde{A}(t) + \tilde{G}/$$

i.e.
$$/\tilde{F}(t)/ = \left\{\frac{h^4 Ao^2(h)}{(v^2t^2 + h^2)^2} + /G/^2 + \frac{2h^2 Ao(h)/\tilde{G}/}{(v^2t^2 + h^2)}\left(\cos\left(\theta - \tan^{-1}\frac{(vt)}{h}\right)\right)\right\}^{1/2} \quad (2.3)$$

(2.3) can be written in terms of the dimensionless combination(st), where $s := v/h$ is a parameter with dimensions of time^{-1}:-

$$/\tilde{F}(t)/ = \left(\frac{Ao^2(h)}{(s^2t^2 + 1)^2} + /\tilde{G}/^2 + \frac{2/\tilde{G}/\,Ao(h)}{(s^2t^2 + 1)}(\cos(\theta - \tan^{-1} st))\right)^{1/2} \quad . \; . \; . \; . \; . \; . \quad (2.4)$$

The anomaly itself is defined by $\tilde{B}(t) = /\tilde{F}(t)/ - /\tilde{G}/$ . . . . (2.4a)

2.3 It is interesting to note that a change in s can be reflected by a change in the time scale t. It will be observed that the transform of (2.4) cannot be performed analytically owing to the $(s^2t^2 + 1)$ factors in the denominators of the appropriate integrals. The next best approximation to the transform is, then, a numerical Fourier series expansion of (2.4) on a finite number of points.

2.4 Before carrying out the required expansions, it will be necessary to determine:-

(a) How many Fourier coefficients will be needed, and
(b) What range of t is required for some particular's' value?

'Worst case' values for v and h were chosen as 50 m/s and 150 m respectively (normal BMR survey limits), making s = 1/3 in equation 2.4. $/\tilde{G}/$ was chosen as 58 000 nT and θ = 1/2 rad. The value of Ao(h), approximately equal to the anomaly peak, was taken as 14 195 nT - larger than that usually encountered

in practice. It is also necessary to know the accuracy of the Fourier series approximation to equation (2.4) and this is examined in Sections (3) and (4).

DETERMINATION OF APPROXIMATE FOURIER EXPANSION PARAMETERS

3.1 Although there is a problem in carrying out the analytic transform of (2.4), the question may still be tackled analytically to a certain extent by considering the energy spectrum of the anomaly. The procedure of taking only a finite number of terms in the expansion of (2.4) is identical to applying a square cutoff characteristic in the frequency domain. This square cutoff may be applied to the energy spectrum in order to obtain an approximate estimate of the errors introduced by neglecting all expansion terms greater than some cutoff frequency ω_T when carrying out the numerical Fourier series expansion of (2.4).

3.2 Consider a magnetometer being flown at constant elevation (h) and velocity (v) above a plane surface containing a point magnetic source of magnetic intensity (m). The fastest rate of change of field with time will occur when the aircraft flies in a straight line which takes it vertically over the magnetic source. Let us, without loss of generality, call this the x direction. The energy at any particular spatial frequency is (Spector, 1968):

$$E(\omega_s) = 4.\pi^2 . m^2 . e^{-2h\omega_s} . (1-\cos^2 I_E \cos^2 D_E) \quad \text{.....(3.1)}$$

where w_s is the spatial frequency, I_E is the inclination of the geomagnetic vector, and D_E the declination. $E(\omega_s)$ is the energy. Transforming to a temporal reference frame gives

$$E(\omega) = 4.\pi^2 . m^2 . e^{\frac{-2h\omega}{v}} . (1-\cos^2 I_E \cos^2 D_E) \quad \text{.....(3.2)}$$

where w has the normal dimensions of angular frequency, v is velocity, and h is unchanged. We may further reduce 3.2 to:-

$$E(\omega) = Q e^{\frac{-2h\omega}{v}} \quad \text{.....(3.3)}$$

where Q is some assumed constant in the vicinity of the point magnetic source.

3.3 The total energy is of more use than the energy at a discrete frequency so integrating (3.3) with respect to w gives:

$$E = \int E(\omega).\, d\omega \quad \text{.....} (3.4)$$

Integrating over all frequencies, i.e. $\omega = 0$ to ∞ will give the total energy contained in the anomaly, Et

$$\text{i.e.:-} \quad Et = \int_0^{\infty} E(\omega).d\omega = \int_0^{\infty} Qe^{\left(\frac{-2h}{v}\right)} d\omega \quad \text{.....} (3.5)$$

$$\text{thus:-} \quad Et = Q\left[-\frac{v}{2h}.e^{\frac{-2h\omega}{v}}\right] = \frac{vQ}{2h} \quad \text{.....} (3.6)$$

Note that Et is a linear function of v and h for constant Q.

3.4 Let us now consider what would happen to this total energy if we were to neglect frequencies greater than ω_T (equivalent to omitting terms containing higher frequencies than ω_T from the Fourier series expansion of the anomaly, before calculating the power spectrum). We apply the 'window' of Figure (3a) to the integral in (3.5).

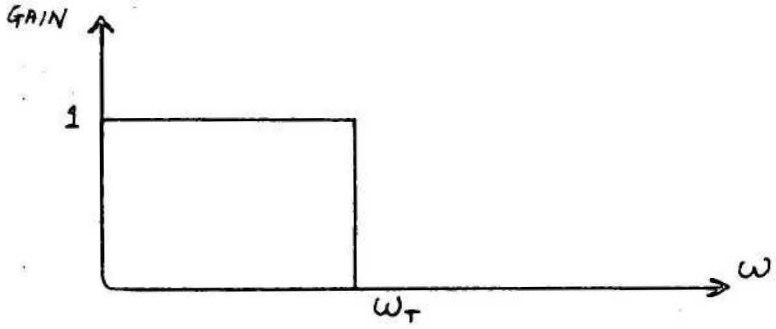

Figure 3(a)

The energy seen in the restricted bandwidth is as follows:

$$E_R = \int_0^{\omega_T} E(\omega).d\omega = Q\left[\frac{-v}{2h}.e^{\left(\frac{-2h\omega}{v}\right)}\right]$$

$$= \frac{vQ}{2h}.\left(1 - e^{\frac{-2h\omega_T}{v}}\right) \quad \text{.....} (3.7)$$

Thus the fractional energy lost outside the 'window' shown in Figure (3a) is

$$\frac{\delta E}{E_T} = e^{\frac{-2h\omega}{v}T} \quad \text{.....} (3.8)$$

3.5 It remains to set limits on E/E_t in order to determine a suitable ω_t. Limits cannot be set on E/E_t directly; it is necessary to relate limits of known parameters such as detector height, anomaly half-widths, and magntiude (for t=0) to anomaly 'energy'.

It will already have been noted in equation 3.6, that for constant Q and v, E_t is a function linear in h.

Differentiating equation 2.2 with respect to height gives:

$$\frac{d/\tilde{A}(t)/}{ch} = \frac{2hkm}{(v^2t^2 + h^2)^2} \quad \text{.....(3.9)}$$

$A(O) = km/h^2$, thus at t = 0:

$$\frac{d/\tilde{A}(O)/}{dh} = \frac{2./\tilde{A}(O)/}{h} \quad \text{.....(3.10)}$$

$$\frac{/\delta\tilde{A}(t)/}{/\tilde{A}(t)/} \cong \frac{2\,h}{h} \quad \text{(at t=0)} \quad \text{.....(3.11)}$$

i.e., a fractional change in height near the anomaly peak will give a fractional change in anomaly 'size' of half this fractional change. (It can also be shown by a consideration of the half-power points on the anomaly, that the same relation exists for the anomaly half-widths as for the height.) From the above relations, it is apparent that $\delta E/E_t = \frac{1}{2}\delta A/A(O)$. It is desirable for the Fourier series expansion of equation (2.4a) to be accurate to $\pm$ 1 nT, a commonly used instrument resolution. This gives a figure of 1/(2.0 x 14195) or approximately 3×10^{-5} for E/E_t.

Substituting in equation 3.8 gives:-

$$\ln(3 \times 10^{-5}) = \frac{-2h\omega_t}{v}$$

$$\text{i.e.:-}\ \omega_T = \frac{-v}{2h}(\ln 3 - 5\ln 10)$$

$$\text{i.e.:-}\ \omega_T = 1.73 \text{ rad/s or } 0.28 \text{ Hz} \quad \text{.....(3.12)}$$

In calculating our Fourier series expansion, we should therefore consider terms up to at least 0.3 Hz and preferably higher. It was decided to consider terms from zero frequency to 0.4 Hz in carrying out the transform.

3.6 It remains to consider the range of time over which the Fourier expansion is carried out. In equation 2.4, we can assume that for large st, $\cos(\theta - \tan^{-1} yt)$ will be of the order of unity (very approximate), and thus

$$/\tilde{F}(t)/ \cong \frac{h\,Ao(h)}{s^2t^2 + 1} + /\tilde{G}/ \qquad \text{.....(3.13)}$$

We require B(t) to have dropped to +1 nT at the two time extremities of the Fourier expansion (otherwise there will be unwanted steps at the start and end of the transform), hence $s^2t^2 + 1 \cong Ao(h)$ [because $/\tilde{F}(t)/ - /\tilde{G}/ \leq 1$]

For $s = 1/3$, $t^2 = 126\,000$ i.e. $t = 355$ seconds. It was decided to take t from -500 to +500 seconds, necessitating 400 coefficients to give terms up to 0.4 Hz (i.e. $\frac{400}{500-(-500)} = 0.4$) for one sample/second. However 1 sample/second is not enough to check accuracy in the fast-changing field around the anomaly *half-power points. 10 points/second or 10 000 points total were therefore chosen.

FOURIER SERIES EXPANSION OF POINT SOURCE ANOMALY

4.1 The expansion is carried out on 10 000 points from -500 to +500 seconds. Four hundred coefficients from zero frequency to 0.399 Hz are required and we also need an error estimate to indicate how closely the transform approximates the 'reality' of equation (2.4a) on each of the 10 000 points.

4.2 The subroutine used to carry out the initial transform was obtained from the SRLIST 6600 library of subroutines available from CSIRO, Canberra (Muncey, Russell, Spencer - 1965). This routine has two relevant entry points, FØURANG and FØUSYNG. FØURANG carries out the Fourier series expansion and FØUSYNG the synthesis with the following parameters, in order:

*'HALF POWER POINTS' are the two points (t_1 and t_2) on an 'anomaly curve' - i.e., field (F) versus time (t) - at which

$$\int_{t_1}^{t_2} F.dt = \tfrac{1}{2}\int_{-\infty}^{+\infty} F.dt$$

NHAR = number of coefficients (=400 here)

NØRD = number of ordinates (=10 000 here)

HARMC = location of cos coefficients

HARMS = location of sin coefficients

ØRDS = location of points to be transformed (FØURANG) or location of inverse transformed points (FØUSYNG)

4.3 A small 6600 FORTRAN program called FØURIER was written to carry out the following:

Produce an array of 10 000 points at 0.1 second time spacings from equation 2.4a; i.e. the array contains values of B(t). The program then calls FØURANG with these values and produces a list and punched card output of the 400 coefficients (cosines and sines). The cos and sin coefficients are then passed to the synthesis program FØUSYNG, which produces an array of 10 000 ordinates from the Fourier coefficients. These points are then compared with the original equation to check the accuracy of the transform representation of the anomaly. Three types of error were checked for:

(a) Root mean square error for the whole anomaly (i.e. all 10 000 points)

(b) The maximum absolute error encountered at any one of the 10 000 points

(c) The maximum percentage error encountered at any one of the 10 000 points

4.4 A program listing and flowchart for FØURIER appear in appendix (A). Appendix (B) contains the list of coefficients produced by FØURIER as well as three error estimates mentioned in 4.3. Appendix (C) contains three oscillograph pictures made using the Hewlett-Packard Fourier Analyser System to give a pictorial view of:-

(a) The anomaly as produced by equation (2.4a)

(b) The real part of the transform of (a)

(c) The imaginary part of the transform of (a)

The scales are approximately as marked alongside the photographs. The quantitative figures produced by the analyser agree well with those of Appendix (B).

4.5 Reference to appendix (B) shows that the absolute error introduced in the Fourier transform by omitting terms higher than 0.4 Hz is less than 0.4 nT at any point and that the greatest percentage error occurs at the same point (i.e. 0.64 nT should really be 0.25 nT). The RMS error for all 10 000 points is 0.05 nT. These low errors confirm the predictions of Section (3) and justify the use of the finite transform of 400 coefficients for use in the work described herein.

MAGNETOMETER BANDWIDTHS

5.1 A third-order transfer function was chosen for this investigation. Reasons for this choice are as follows:

(a) Commercial and BMR magnetometers have bandwidth characteristics which are usually of higher order than three; this means that any conclusions drawn here will set an absolute minimum standard. Thus, magnetometers with higher-order bandwidths than three will generally be required to have even wider bandwidths than those demanded of third-order systems.

(b) The BMR designed MFS7 fluxgate magnetometer (Kerr & Seers, in prep.) has a lowpass characteristic which is third order. This magnetometer uses a detector which operates in a zero field provided by a feedback mechanism consisting of a bandpass filter, chopper phase detector, and integrator. Amplitude modulation of the fluxgate signal in the forward path provides a transformed lowpass characteristic. The transfer function used in this investigation fits the MFS7 response theoretically and in actual test to better than $\pm$ 0.4 dB or $\pm$ 5%. The transfer function consists of a gain term, real pole, and a complex pair of poles.

5.2 Appendix (D) contains part of a MANYPLOT analysis (Kerr, 1973) of the set of poles comprising the transfer function for 10 Hz bandwidth (at the 3dB points). Sets of poles were calculated for seven different bandwidths at intervals of 1, 2, 5, 10, 20, 50, and 100 Hz. The response curves

are all the one shape for these bandwidths. Multiplying the horizontal frequency scale of the 10 Hz curve by 0.1, 0.2, 0, 5, 1, 2, 5, and 10 respectively will give the appropriate curve for each of the seven bandwidths mentioned above.

APPLICATION OF TRANSFER FUNCTION, INVERSE TRANSFORM AND ERRORS

6.1 A general purpose program, ANØMALY, was written to:

(a) Apply the transfer function (comprising up to 24 arbitrary poles and/or 24 zeros and a gain term) to the Fourier coefficients.

(b) Calculate the unmodified anomaly from the unfiltered coefficients and also the modified anomaly. The calculations are carried out on non-equal intervals depending on the slope of the curve at the appropriate points.

(c) Print out the unmodified and modified anomaly (1000 points each). Call Subroutine ERRPLØT to plot error directly in nT versus time, and percentage error versus time. ERRPLØT carried out labelling and drawing of these two plots. Program listings for ANØMALY and ERRPLØT, with flowcharts, appear in APPENDIX (E) (note that no account of phase information is taken in these plots).

6.2 ANØMALY and ERRPLØT are written in CDC 3600 FORTRAN for the CSIRO DAD system. Plotting is carried out on the 12-inch Calcomp drum plotter. ANØMALY produces a card deck containing both the modified and unmodified anomalies. If necessary, ANØMALY can take its input directly from such a deck. The coefficients are read by the program from either drum or disc and an image of the punched card output is placed on the disc for later possible reference. Execution was always straight from drum.

6.3 ANØMALY takes 10 minutes of CPU time for only 958 points and this is why the program has been restricted to that number of points. Several runs (5 to 10) are required to produce only one error bandwidth curve and the cost can become prohibitive if too many points are required. The points are printed across the page in eight rows and down in 62½ rows per each of 2 pages. The time intervals are organized as follows:-

(a) Points 1 to 28:- 15 s between points; cumulative time = -500 to -95 s

(b) Points 28 to 35:- 5 s between points; cumulative time = -60 s

(c) Points 35 to 55:- 1 s between points; cumulative time = -40 s

(d) Points 55 to 130:- 0.2 s between points; cumulative time = -25 s

(e) Points 130 to 280:- 0.1 s between points; cumulative time = -10 s

(f) Points 280 to 480:- 0.05 s between points; cumulative time = 0 s

(g) Points 480 to 680:- 0.05 s between points; cumulative time = +10 s

(h) Points 680 to 830:- 0.1 s between points; cumulative time = +25 s

(i) Points 830 to 905:- 0.2 s between points; cumulative time = +40 s

(j) Points 905 to 925:- 1 s between points; cumulative time = +60 s

(k) Points 925 to 932:- 5 s between points; cumulative time = +95 s

(l) Points 932 to 958:- 15 s between points; cumulative time = +500 s

6.4 Appendix (F) contains the print-outs for the first six of the bandwidths mentioned in 5.1. Included with each set of print-outs are two plots of error against time. Two plots (but no printout) for 100 Hz bandwidth are also attached. It is seen that, as expected, errors drop as the bandwidth increases. The results are described in detail in Sections 7 and 8.

EVALUATION OF RESULTS

7.1 Apart from errors decreasing with bandwidth, another feature of the error curves is the difference between the point of maximum error and the point of maximum percentage error for a given bandwidth. The maximum absolute error occurs just before the anomaly peak (the second greatest error occurs on the other side of the anomaly peak). The error changes sign at the anomaly peak; this is as expected because the recorded anomaly will always lag behind the true field by a certain amount. This maximum absolute error indicates the point of maximum rate of change of field of the anomaly, which is 4520 nT/s (result from the inverse transformed unfiltered anomaly). The greatest percentage error occurs at the zero crossing of the anomaly at about -8 seconds, where the rate of field change is reasonably large (i.e. 250 nT/s). This error may be resolved as a phase error in the zero crossing point of the anomaly.

7.2 The peak of the anomaly will be in error in both phase and amplitude - i.e. the peak of the anomaly occurs at the wrong point in time and is of the wrong magnitude. The phase error may be converted to an equivalent positional error through a knownledge of the aircraft velocity, and the plots then corrected for this phase error.

7.3 Three curves were plotted, all versus bandwodth, to show the sizes of the various errors:

(a) Maximum error versus bandwidth (corrected for phase).

(b) Amplitude error of anomaly peak versus bandwidth (corrected for phase).

(c) Phase error of anomaly peak and phase error of zero crossing versus bandwidth (both the identical curve).

These curves are displayed in Appendix (G). The phase curves are least accurate owing to the numbers of points used, and error bars on curve (C) show the extent of this. The other curves are accurate to within ± 1 nT.

CONCLUSIONS

8.1 It is obviously difficult to draw a line below which magnetometer response is unsatisfactory and above which response is acceptable. It is fairly obvious, however, from the curves that a response of 1 Hz bandwidth looks barely satisfactory in most applications, while a bandwidth of 100 Hz would be more than satisfactory. Too high a bandwidth can, however, have associated noise complications. It is necessary, therefore, to select the minimum satisfactory bandwidth commensurate with good noise performance.

8.2 Positional information is rarely required to better than ± 10 metres. A bandwidth of 1 Hz would therefore fulfil this requirement (see Appendix G), Graph (c)).

8.3 The amplitude of anomaly peaks is seldom required to better than 1 percent. A bandwidth of 1 Hz giving 0.5 percent would thus be satisfactory (see Appendix G), Graph (b)).

8.4 At the 'point of maximum error' on the anomaly (Graph (a), Appendix (G)), the rate of change of field is 4500 nT/s (see 7.1). A positional error of 10 m here is equivalent to about 900 nT at 50 m/s aircraft velocity. A bandwidth of 1 Hz would be more than satisfactory to fulfil the requirements at this point (i.e. 230 nT at 1 Hz - see graph (a)).

8.5 A magnetometer should be able to 'follow' the fastest rate of change of field (slew rate) on the anomaly, which is 4520 nT/s, with less than 900 nT (20%) error at any point, if the error contribution from magnetometer response is to be kept less than that due to uncertainty of aircraft position (see 8.4).

8.6 It would appear from the foregoing, then, that survey magnetometers with a third-order or higher-order lowpass bandwidth as described here must have a bandwidth of no less than 1 Hz and a slew rate in excess of 5000 nT/s. The results of Sections 3 and 4 show that a digital sampling rate of 1/second is more than adequate to specify a 'worst case anomaly' of 14 000 nT to better than 0.4 nT at any point, with less than 0.05 nT error over the entire anomaly.

9. REFERENCES

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APPENDIX A

B(1) to B(3) - PROGRAM LISTING FOR 'FØURIER'

B(4) - FLOWCHART FOR 'FØURIER'

```
$SEQUENCE,MEX.
CHARGE,C60213J-RDA.
FOURIER(P6,CM100000,CL100000)
RUN(G)
0000000000000000000000
      PROGRAM FOURIER(INPUT,OUTPUT,PUNCH)
      DIMENSION F(10002),FT(10002),HARMC(500),HARMS(500)
      PRINT 10
   10 FORMAT(1H1,5X*FOURIER ANALYSIS OF THEORETICAL POINT SOURCE ANOMALY
     1*///)
      PRINT 60
   60 FORMAT(6X*TRANSFORM INTERVAL IS 1.000 SECS, DIVIDED INTO 10,000 PO
     1INTS*)
      PRINT 70
   70 FORMAT(5X*FREQUENCY*4X*COS COEFF*8X*SIN COEFF*)
      ALPHA=-1.0E15
      BETA=-1.0E15
      DELTA=-1.0E15
      SOD=0.
      PHI=-500.
      FREQ=0.0
      DO 20 I=1,10000
      F(I)=SQRT(2.0792E8/(((PHI**2)/9.+1.)**2)+3.364E9+(1.67265E9/((PHI
     1**2)/9.+1.))*COS(.5-ATAN(PHI/3.)))-5.8E4
      FT(I)=F(I)
   20 PHI=PHI+0.1
      CALL FOURANG(400,10000,HARMC,HARMS,F)
      PUNCH 30,HARMC,HARMS
   30 FORMAT(E15.8,4X,E15.8,4X,E15.8,4X,E15.8)
      DO 50 I=1,400
      PRINT 40,FREQ,HARMC(I),HARMS(I)
   40 FORMAT(5X,F5.1,8X,E13.6,4X,E13.6)
   50 FREQ=FREQ+0.1
      CALL FOUSYNG(400,10000,HARMC,HARMS,F)
      DO 99 I=1,10000
      POD=F(I)-FT(I)
      POD=POD*POD
      DOD=SQRT(POD)
      IF((DOD/FT(I)).GT.DELTA)BETA=FT(I)
      IF((DOD/FT(I)).GT.DELTA)DELTA=DOD/FT(I)
      IF(DOD.GT.ALPHA)ALPHA=DOD
   99 SOD=SOD+POD
      DELTA=DELTA*100.
      SOD=SQRT(SOD/10000.)
      PRINT 80,SOD,ALPHA
   80 FORMAT(1H1,5X,*RMS ERROR =*,E11.4,/5X* MAXIMUM ERROR =*,E11.4* GAM
     1MAS*)
      PRINT 90,DELTA,BETA
   90 FORMAT(6X*MAX PERCENTAGE ERROR =*,E11.4,* AT *E11.4* GAMMAS,*)
      END
      SUBROUTINE FOURANG(NHAR,NORD,HARMC,HARMS,ORDS)                    FOURA002
      DIMENSION HARMC(1),HARMS(1),ORDS(1)                               FOURA003
      M1=NORD/2                                                         FOURA004
      M2=M1+1                                                           FOURA005
      M3=(NORD+1)/2                                                     FOURA006
      IF(NHAR-M2) 90,90,60                                              FOURA007
   60 WRITE(6,70) NHAR,M2                                               FOURA008
   70 FORMAT(/8H TOO MAN,8HY HAR ON,8HICS CALL,8HED FOR (,I5,8H),PROGRA FOURA009
     ,8HM HAS CA,8HLCULATED,8H MAXIMUM,8H NUMBER ,8HPOSSIBLE,1H(,I5,    FOURA010
     ,1H)//)                                                            FOURA011
      NHAR=M2                                                           FOURA012
   80 ARG=6.283185307/FLOAT(NORD)                                       FOURA013
      CB=COS(ARG)                                                       FOURA014
      SB=SIN(ARG)                                                       FOURA015
      CA=1.                                                             FOURA016
```

```
      K=1                                                               FOURA018
141   IF(K.GT.NHAR) GOTO 149                                            FOURA019
      UC=0.                                                             FOURA020
      UB=UC                                                             FOURA021
      J=NORD                                                            FOURA022
170   UA=ORDS(J)+2E0*CA*UB-UC                                           FOURA023
      UC=UB                                                             FOURA024
      UB=UA                                                             FOURA025
      J=J-1                                                             FOURA026
      IF(J-1) 220,220,170                                               FOURA027
220   HARMC(K)=2E0*(ORDS(1)+CA*UB-UC)/FLOAT(NORD)                       FOURA028
      HARMS(K)=2E0*SA*UB/FLOAT(NORD)                                    FOURA029
      UA=CB*CA-SB*SA                                                    FOURA030
      SA=CB*SA+SB*CA                                                    FOURA031
      CA=UA                                                             FOURA032
      K=K+1                                                             FOURA033
      GOTO 141                                                          FOURA034
149   CONTINUE                                                          FOURA035
      HARMC(1)=HARMC(1)/2.                                              FOURA036
      IF(.NOT.(M1.EQ.M3.AND.NHAR.EQ.M2)) GOTO 310                       FOURA037
      HARMC(NHAR)=HARMC(NHAR)/2.                                        FOURA038
      HARMS(NHAR)=0.                                                    FOURA039
310   GOTO 590                                                          FOURA040
      ENTRY FOUSYNG                                                     FOURA041
      ARG=6.283185307/FLOAT(NORD)                                       FOURA042
      CB=COS(ARG)                                                       FOURA043
      CA=CB                                                             FOURA044
      SB=SIN(ARG)                                                       FOURA045
      SA=SB                                                             FOURA046
      K=2                                                               FOURA047
361   IF(K.GT.NHAR) GOTO 369                                            FOURA048
      VC=0.                                                             FOURA049
      VB=VC                                                             FOURA050
      UC=VB                                                             FOURA051
      UB=UC                                                             FOURA052
      J=NHAR                                                            FOURA053
390   UA=HARMC(J)-UC+2E0*CA*UB                                          FOURA054
      VA=HARMS(J)-VC+2E0*SA*VB                                          FOURA055
      UC=UB                                                             FOURA056
      UB=UA                                                             FOURA057
      VC=VB                                                             FOURA058
      VB=VA                                                             FOURA059
      J=J-1                                                             FOURA060
      IF(J-1) 470,470,390                                               FOURA061
470   XB=HARMC(1)-UC+CA*UB                                              FOURA062
      XC=VB*SA                                                          FOURA063
      ORDS(K)=XB+XC                                                     FOURA064
      KMOD=NORD-K+2                                                     FOURA065
      ORDS(KMOD)=XB-XC                                                  FOURA066
      UA=CB*CA-SB*SA                                                    FOURA067
      SA=CB*SA+SB*CA                                                    FOURA068
      CA=UA                                                             FOURA069
      K=K+1                                                             FOURA070
      GOTO 361                                                          FOURA071
369   CONTINUE                                                          FOURA072
      XBA=0                                                             FOURA073
      J=1                                                               FOURA074
561   IF(J.GT.NHAR) GOTO 569                                            FOURA075
      XBA=XBA+HARMC(J)                                                  FOURA076
      J=J+1                                                             FOURA077
      GOTO 561                                                          FOURA078
569   CONTINUE                                                          FOURA079
      ORDS(1)=XBA                                                       FOURA080
590   RETURN                                                            FOURA081
      END                                                               FOURA082
```

APPENDIX B

B(1) to B(8) - OUTPUT FROM 'FØURIER'

('FOURIER' COEFFICIENTS OF POINT SOURCE ANOMALY)

FOURIER ANALYSIS OF THEORETICAL POINT SOURCE ANOMALY

B(1)

TRANSFORM INTERVAL IS 1.000 SECS. DIVIDED INTO 10,000 POINTS

FREQUENCY	COS COEFF	SIN COEFF
0.000	7.873408E+01	0.
.001	-1.573461E+02	-6.442696E+00
.002	1.570430E+02	1.042025E+01
.003	-1.566076E+02	-1.389176E+01
.004	1.560598E+02	1.663156E+01
.005	-1.554166E+02	-1.914337E+01
.006	1.546889E+02	2.122550E+01
.007	-1.538873E+02	-2.316380E+01
.008	1.530190E+02	2.480158E+01
.009	-1.520916E+02	-2.633751E+01
.010	1.511104E+02	2.764509E+01
.011	-1.500813E+02	-2.887633E+01
.012	1.490084E+02	2.992549E+01
.013	-1.478965E+02	-3.091557E+01
.014	1.467488E+02	3.175584E+01
.015	-1.455694E+02	-3.254953E+01
.016	1.443608E+02	3.321724E+01
.017	-1.431265E+02	-3.384786E+01
.018	1.418686E+02	3.437079E+01
.019	-1.405901E+02	-3.486409E+01
.020	1.392927E+02	3.526421E+01
.021	-1.379791E+02	-3.564069E+01
.022	1.366507E+02	3.593576E+01
.023	-1.353098E+02	-3.621210E+01
.024	1.339576E+02	3.641676E+01
.025	-1.325962E+02	-3.660678E+01
.026	1.312266E+02	3.673328E+01
.027	-1.298506E+02	-3.684859E+01
.028	1.284690E+02	3.690731E+01
.029	-1.270834E+02	-3.695777E+01
.030	1.256947E+02	3.695758E+01
.031	-1.243042E+02	-3.695164E+01
.032	1.229126E+02	3.690020E+01
.033	-1.215210E+02	-3.684517E+01
.034	1.201302E+02	3.674912E+01
.035	-1.187411E+02	-3.665136E+01
.036	1.173542E+02	3.651651E+01
.037	-1.159707E+02	-3.638157E+01
.038	1.145907E+02	3.621301E+01
.039	-1.132153E+02	-3.604578E+01
.040	1.118447E+02	3.584801E+01
.041	-1.104799E+02	-3.565279E+01
.042	1.091209E+02	3.542977E+01
.043	-1.077686E+02	-3.521038E+01
.044	1.064232E+02	3.496563E+01
.045	-1.050853E+02	-3.472545E+01
.046	1.037550E+02	3.446211E+01
.047	-1.024331E+02	-3.420415E+01
.048	1.011194E+02	3.392499E+01
.049	-9.981480E+01	-3.365193E+01
.050	9.851908E+01	3.335943E+01
.051	-9.723293E+01	-3.307367E+01
.052	9.595622E+01	3.277007E+01
.053	-9.468956E+01	-3.247373E+01
.054	9.343277E+01	3.216100E+01
.055	-9.218646E+01	-3.185600E+01
.056	9.095039E+01	3.153592E+01

B(2)

.059	-8.730686E+01	-3.050076E+01
.060	8.611409E+01	3.025056E+01
.061	-8.493265E+01	-2.992914E+01
.062	8.376223E+01	2.959546E+01
.063	-8.260334E+01	-2.927162E+01
.064	8.145563E+01	2.894641E+01
.065	-8.031958E+01	-2.861043E+01
.066	7.919484E+01	2.827429E+01
.067	-7.808186E+01	-2.794756E+01
.068	7.698028E+01	2.761140E+01
.069	-7.589051E+01	-2.728478E+01
.070	7.481220E+01	2.694941E+01
.071	-7.374574E+01	-2.662370E+01
.072	7.269075E+01	2.628983E+01
.073	-7.164762E+01	-2.596570E+01
.074	7.061595E+01	2.563398E+01
.075	-6.959613E+01	-2.531205E+01
.076	6.858774E+01	2.498304E+01
.077	-6.759116E+01	-2.466386E+01
.078	6.660595E+01	2.433806E+01
.079	-6.563249E+01	-2.402210E+01
.080	6.467033E+01	2.369994E+01
.081	-6.371983E+01	-2.338763E+01
.082	6.278055E+01	2.306951E+01
.083	-6.185284E+01	-2.276121E+01
.084	6.093624E+01	2.244746E+01
.085	-6.003110E+01	-2.214350E+01
.086	5.913695E+01	2.183440E+01
.087	-5.825413E+01	-2.153506E+01
.088	5.738218E+01	2.123087E+01
.089	-5.652143E+01	-2.093638E+01
.090	5.567140E+01	2.063732E+01
.091	-5.483243E+01	-2.034788E+01
.092	5.400403E+01	2.005412E+01
.093	-5.318652E+01	-1.976991E+01
.094	5.237944E+01	1.948160E+01
.095	-5.158309E+01	-1.920276E+01
.096	5.079700E+01	1.892002E+01
.097	-5.002148E+01	-1.864667E+01
.098	4.925604E+01	1.836960E+01
.099	-4.850100E+01	-1.810182E+01
.100	4.775587E+01	1.783049E+01
.101	-4.702095E+01	-1.756836E+01
.102	4.629577E+01	1.730283E+01
.103	-4.558062E+01	-1.704639E+01
.104	4.487502E+01	1.678669E+01
.105	-4.417927E+01	-1.653598E+01
.106	4.349289E+01	1.628213E+01
.107	-4.281617E+01	-1.603716E+01
.108	4.214862E+01	1.578917E+01
.109	-4.149055E+01	-1.554993E+01
.110	4.084146E+01	1.530778E+01
.111	-4.020167E+01	-1.507428E+01
.112	3.957066E+01	1.483795E+01
.113	-3.894875E+01	-1.461016E+01
.114	3.833545E+01	1.437962E+01
.115	-3.773105E+01	-1.415749E+01
.116	3.713506E+01	1.393270E+01
.117	-3.654779E+01	-1.371620E+01
.118	3.596874E+01	1.349710E+01
.119	-3.539822E+01	-1.328617E+01
.120	3.483572E+01	1.307271E+01
.121	-3.428156E+01	-1.286730E+01
.122	3.373525E+01	1.265941E+01

B(3)

.124	3.266656E+01	1.225705E+01
.125	-3.214401E+01	-1.206247E+01
.126	3.162892E+01	1.186550E+01
.127	-3.112161E+01	-1.167621E+01
.128	3.062158E+01	1.144458E+01
.129	-3.012914E+01	-1.130051E+01
.130	2.964381E+01	1.111413E+01
.131	-2.916588E+01	-1.093520E+01
.132	2.869487E+01	1.075398E+01
.133	-2.823110E+01	-1.058010E+01
.134	2.777407E+01	1.040396E+01
.135	-2.732409E+01	-1.023502E+01
.136	2.688067E+01	1.006386E+01
.137	-2.644414E+01	-9.894790E+00
.138	2.601400E+01	9.733509E+00
.139	-2.559057E+01	-9.574206E+00
.140	2.517336E+01	9.412710E+00
.141	-2.476268E+01	-9.258077E+00
.142	2.435807E+01	9.101267E+00
.143	-2.395982E+01	-8.951206E+00
.144	2.356747E+01	8.798982E+00
.145	-2.318132E+01	-8.653396E+00
.146	2.280090E+01	8.505658E+00
.147	-2.242653E+01	-8.364448E+00
.148	2.205773E+01	8.221095E+00
.149	-2.169482E+01	-8.084162E+00
.150	2.133732E+01	7.945094E+00
.151	-2.098555E+01	-7.812338E+00
.152	2.063905E+01	7.677455E+00
.153	-2.029813E+01	-7.548778E+00
.154	1.996232E+01	7.417978E+00
.155	-1.963195E+01	-7.293282E+00
.156	1.930653E+01	7.166468E+00
.157	-1.898641E+01	-7.045654E+00
.158	1.867111E+01	6.922726E+00
.159	-1.836095E+01	-6.805698E+00
.160	1.805548E+01	6.686557E+00
.161	-1.775501E+01	-6.573219E+00
.162	1.745908E+01	6.457770E+00
.163	-1.716802E+01	-6.348027E+00
.164	1.688137E+01	6.236173E+00
.165	-1.659946E+01	-6.129930E+00
.166	1.632182E+01	6.021577E+00
.167	-1.604879E+01	-5.918741E+00
.168	1.577990E+01	5.813795E+00
.169	-1.551550E+01	-5.714276E+00
.170	1.525512E+01	5.612646E+00
.171	-1.499909E+01	-5.516353E+00
.172	1.474696E+01	5.417948E+00
.173	-1.449907E+01	-5.324792E+00
.174	1.425495E+01	5.229523E+00
.175	-1.401496E+01	-5.139417E+00
.176	1.377852E+01	5.047197E+00
.177	-1.354629E+01	-4.960055E+00
.178	1.331750E+01	4.870798E+00
.179	-1.309260E+01	-4.786537E+00
.180	1.287114E+01	4.700158E+00
.181	-1.265346E+01	-4.618694E+00
.182	1.243911E+01	4.535112E+00
.183	-1.222843E+01	-4.456365E+00
.184	1.202098E+01	4.375497E+00
.185	-1.181709E+01	-4.299388E+00
.186	1.161633E+01	4.221157E+00
.187	-1.141903E+01	-4.147608E+00
.188	1.122475E+01	4.071935E+00

B(4)

.191	-1.066114E+01	-3.859026E+00
.192	1.047926E+01	3.788245E+00
.193	-1.030055E+01	-3.721928E+00
.194	1.012458E+01	3.653483E+00
.195	-9.951699E+00	-3.589433E+00
.196	9.781463E+00	3.523253E+00
.197	-9.614227E+00	-3.461401E+00
.198	9.449549E+00	3.397418E+00
.199	-9.287784E+00	-3.337697E+00
.200	9.128493E+00	3.275843E+00
.201	-8.972033E+00	-3.218186E+00
.202	8.817962E+00	3.158396E+00
.203	-8.666641E+00	-3.102739E+00
.204	8.517630E+00	3.044950E+00
.205	-8.371288E+00	-2.991231E+00
.206	8.227179E+00	2.935379E+00
.207	-8.085662E+00	-2.883537E+00
.208	7.946301E+00	2.829561E+00
.209	-7.809458E+00	-2.779537E+00
.210	7.674698E+00	2.727379E+00
.211	-7.542382E+00	-2.679115E+00
.212	7.412078E+00	2.628718E+00
.213	-7.284148E+00	-2.582157E+00
.214	7.158160E+00	2.533464E+00
.215	-7.034477E+00	-2.488553E+00
.216	6.912668E+00	2.441510E+00
.217	-6.793099E+00	-2.398194E+00
.218	6.675338E+00	2.352748E+00
.219	-6.559751E+00	-2.310977E+00
.220	6.445909E+00	2.267076E+00
.221	-6.334179E+00	-2.226799E+00
.222	6.224132E+00	2.184394E+00
.223	-6.116135E+00	-2.145562E+00
.224	6.009761E+00	2.104604E+00
.225	-5.905379E+00	-2.067169E+00
.226	5.802562E+00	2.027611E+00
.227	-5.701679E+00	-1.991528E+00
.228	5.602303E+00	1.953324E+00
.229	-5.504807E+00	-1.918548E+00
.230	5.408763E+00	1.881653E+00
.231	-5.314545E+00	-1.848141E+00
.232	5.221726E+00	1.812512E+00
.233	-5.130680E+00	-1.780221E+00
.234	5.040981E+00	1.745816E+00
.235	-4.953005E+00	-1.714706E+00
.236	4.866326E+00	1.681485E+00
.237	-4.781320E+00	-1.651516E+00
.238	4.697564E+00	1.619439E+00
.239	-4.615432E+00	-1.590572E+00
.240	4.534502E+00	1.559601E+00
.241	-4.455151E+00	-1.531799E+00
.242	4.376957E+00	1.501897E+00
.243	-4.300296E+00	-1.475124E+00
.244	4.224748E+00	1.446255E+00
.245	-4.150689E+00	-1.420477E+00
.246	4.077701E+00	1.392606E+00
.247	-4.006160E+00	-1.367787E+00
.248	3.935647E+00	1.340880E+00
.249	-3.866541E+00	-1.316988E+00
.250	3.798423E+00	1.291013E+00
.251	-3.731672E+00	-1.268017E+00
.252	3.665870E+00	1.242942E+00
.253	-3.601397E+00	-1.220810E+00
.254	3.537835E+00	1.196604E+00

B(5)

.256	3.414105E+00	1.151740E+00
.257	-3.354028E+00	-1.131447E+00
.258	3.294726E+00	1.108892E+00
.259	-3.236645E+00	-1.089177E+00
.260	3.179369E+00	1.067404E+00
.261	-3.123290E+00	-1.048440E+00
.262	3.067962E+00	1.027423E+00
.263	-3.013798E+00	-1.009183E+00
.264	2.960373E+00	9.888960E-01
.265	-2.908070E+00	-9.713547E-01
.266	2.856476E+00	9.517721E-01
.267	-2.805973E+00	-9.349050E-01
.268	2.756148E+00	9.160026E-01
.269	-2.707385E+00	-8.997859E-01
.270	2.659270E+00	8.815399E-01
.271	-2.612188E+00	-8.659507E-01
.272	2.565727E+00	8.483384E-01
.273	-2.520270E+00	-8.333543E-01
.274	2.475407E+00	8.163535E-01
.275	-2.431521E+00	-8.019532E-01
.276	2.388202E+00	7.855425E-01
.277	-2.345835E+00	-7.717052E-01
.278	2.304009E+00	7.558639E-01
.279	-2.263109E+00	-7.425694E-01
.280	2.222725E+00	7.272776E-01
.281	-2.183243E+00	-7.145066E-01
.282	2.144254E+00	6.997449E-01
.283	-2.106142E+00	-6.874786E-01
.284	2.068499E+00	6.732283E-01
.285	-2.031712E+00	-6.614485E-01
.286	1.995371E+00	6.476917E-01
.287	-1.959863E+00	-6.363810E-01
.288	1.924779E+00	6.231001E-01
.289	-1.890508E+00	-6.122414E-01
.290	1.856639E+00	5.994197E-01
.291	-1.823562E+00	-5.889968E-01
.292	1.790867E+00	5.766179E-01
.293	-1.758944E+00	-5.666149E-01
.294	1.727384E+00	5.546632E-01
.295	-1.696575E+00	-5.450649E-01
.296	1.666111E+00	5.335250E-01
.297	-1.636379E+00	-5.243167E-01
.298	1.606973E+00	5.131740E-01
.299	-1.578281E+00	-5.043414E-01
.300	1.549897E+00	4.935819E-01
.301	-1.522211E+00	-4.851113E-01
.302	1.494814E+00	4.747211E-01
.303	-1.468098E+00	-4.665992E-01
.304	1.441656E+00	4.565652E-01
.305	-1.415878E+00	-4.487793E-01
.306	1.390356E+00	4.390887E-01
.307	-1.365483E+00	-4.316263E-01
.308	1.340852E+00	4.222668E-01
.309	-1.316853E+00	-4.151161E-01
.310	1.293082E+00	4.060758E-01
.311	-1.269927E+00	-3.992252E-01
.312	1.246985E+00	3.904927E-01
.313	-1.224647E+00	-3.839311E-01
.314	1.202506E+00	3.754952E-01
.315	-1.180955E+00	-3.692120E-01
.316	1.159589E+00	3.610621E-01
.317	-1.138798E+00	-3.550468E-01
.318	1.118179E+00	3.471725E-01
.319	-1.098123E+00	-3.414153E-01
.320	1.078225E+00	3.338067E-01

B(6)

.322	1.039577E+00	3.2[illegible]E-01
.323	-1.021015E+00	-3.156756E-01
.324	1.002496E+00	3.085699E-01
.325	-9.844850E-01	-3.035303E-01
.326	9.666064E-01	2.966625E-01
.327	-9.492431E-01	-2.918444E-01
.328	9.319915E-01	2.852059E-01
.329	-9.152443E-01	-2.806010E-01
.330	8.985981E-01	2.741834E-01
.331	-8.824458E-01	-2.697837E-01
.332	8.663839E-01	2.635790E-01
.333	-8.508058E-01	-2.593768E-01
.334	8.353081E-01	2.533772E-01
.335	-8.202843E-01	-2.493650E-01
.336	8.053313E-01	2.435632E-01
.337	-7.908425E-01	-2.397337E-01
.338	7.764152E-01	2.341224E-01
.339	-7.624429E-01	-2.304688E-01
.340	7.485230E-01	2.250411E-01
.341	-7.350493E-01	-2.215566E-01
.342	7.216191E-01	2.163058E-01
.343	-7.086266E-01	-2.129841E-01
.344	6.956692E-01	2.079037E-01
.345	-6.831411E-01	-2.047385E-01
.346	6.706399E-01	1.998223E-01
.347	-6.585601E-01	-1.968077E-01
.348	6.464993E-01	1.920497E-01
.349	-6.348520E-01	-1.891798E-01
.350	6.232163E-01	1.845744E-01
.351	-6.119865E-01	-1.818437E-01
.352	6.007609E-01	1.773851E-01
.353	-5.899340E-01	-1.747883E-01
.354	5.791042E-01	1.704712E-01
.355	-5.686662E-01	-1.680031E-01
.356	5.582183E-01	1.638224E-01
.357	-5.481556E-01	-1.614780E-01
.358	5.380763E-01	1.574286E-01
.359	-5.283756E-01	-1.552032E-01
.360	5.186520E-01	1.512804E-01
.361	-5.093007E-01	-1.491693E-01
.362	4.999203E-01	1.453684E-01
.363	-4.909061E-01	-1.433673E-01
.364	4.818568E-01	1.396837E-01
.365	-4.731679E-01	-1.377883E-01
.366	4.644382E-01	1.342179E-01
.367	-4.560631E-01	-1.324240E-01
.368	4.476417E-01	1.289626E-01
.369	-4.395695E-01	-1.272662E-01
.370	4.314455E-01	1.239099E-01
.371	-4.236655E-01	-1.223072E-01
.372	4.158285E-01	1.190520E-01
.373	-4.083303E-01	-1.175395E-01
.374	4.007702E-01	1.143817E-01
.375	-3.935439E-01	-1.129557E-01
.376	3.862509E-01	1.099918E-01
.377	-3.792870E-01	-1.085489E-01
.378	3.722517E-01	1.055755E-01
.379	-3.655409E-01	-1.043124E-01
.380	3.587542E-01	1.014261E-01
.381	-3.522876E-01	-1.002398E-01
.382	3.457406E-01	9.743743E-02
.383	-3.395095E-01	-9.632468E-02
.384	3.331939E-01	9.360323E-02
.385	-3.271900E-01	-9.256120E-02
.386	3.210976E-01	8.991767E-02

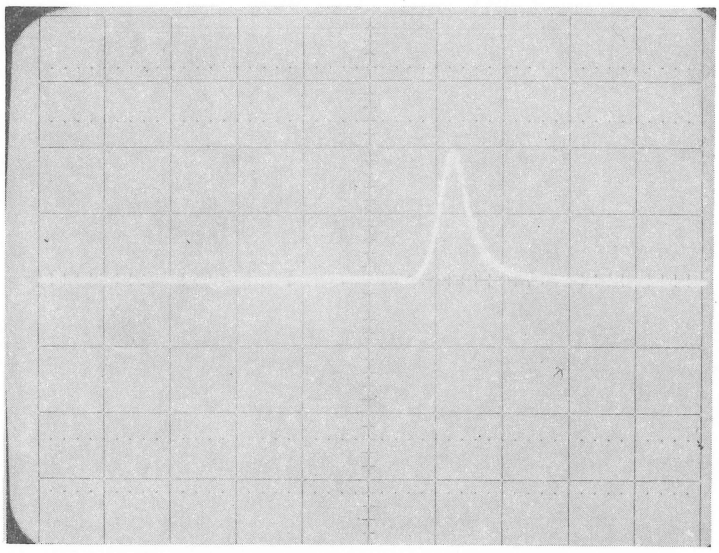
B(7)

.389	-3.038623E-01	-8.546614E-02
.390	2.981927E-01	8.296999E-02
.391	-2.929233E-01	-8.212355E-02
.392	2.873539E-01	7.969717E-02
.393	-2.821812E-01	-7.791090E-02
.394	2.769050E-01	7.655155E-02
.395	-2.719219E-01	-7.582295E-02
.396	2.668320E-01	7.352827E-02
.397	-2.620320E-01	-7.285502E-02
.398	2.571218E-01	7.062265E-02
.399	-2.524981E-01	-7.000250E-02

RMS ERROR = 5.4679E-02
MAXIMUM ERROR = 3.2917E-01 GAMMAS
MAX PERCENTAGE ERROR = 1.5462E+02 AT 2.5169E-01 GAMMAS. (≡ nT)

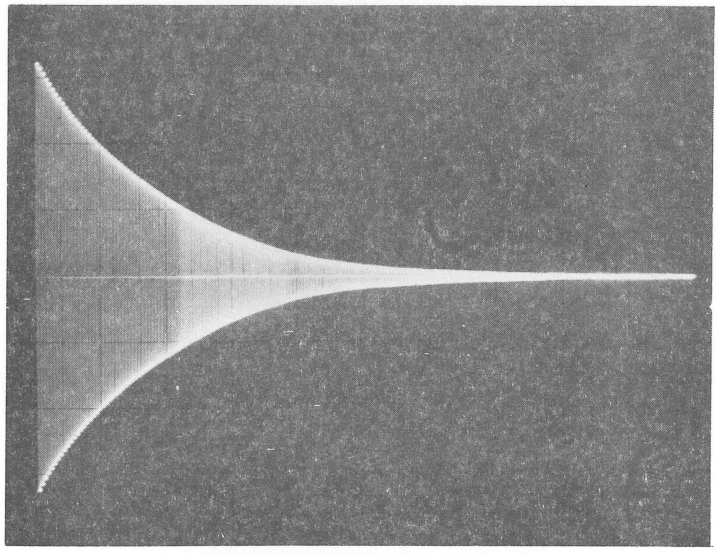
APPENDIX C

C(1) - 3 OSCILLOGRAPH PHOTOGRAPHS



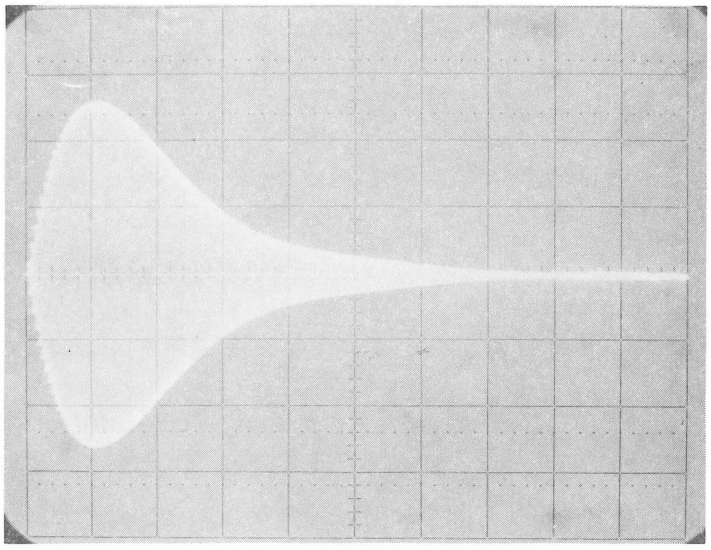
(a) Theoretical point source aeromagnetic anomaly.

Horizontal scale: -500 to +500 s.
Vertical scale: linear, 7000 nT/cm.
1 Division = 1 cm



(b) Real part of the Fourier transform of equation 2.4a.

Horizontal scale: 0.0 to 0.5 Hz (linear): .05 Hz/cm.
Vertical scale: linear 50 units/cm.
1 Division = 1 cm.



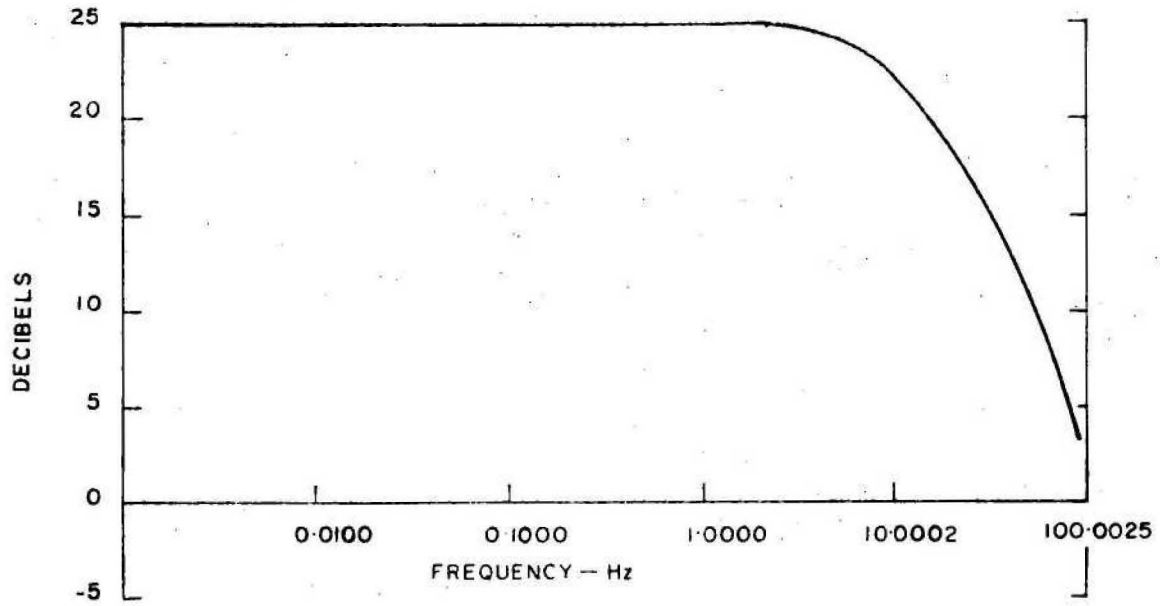
(c) Imaginary part of the Fourier transform of equation 2.4a.

Horizontal scale: 0.0 to 0.5 Hz (linear): .05 Hz/cm.
Vertical scale: linear 50 units/cm.
1 Division = 1 cm.

APPENDIX D

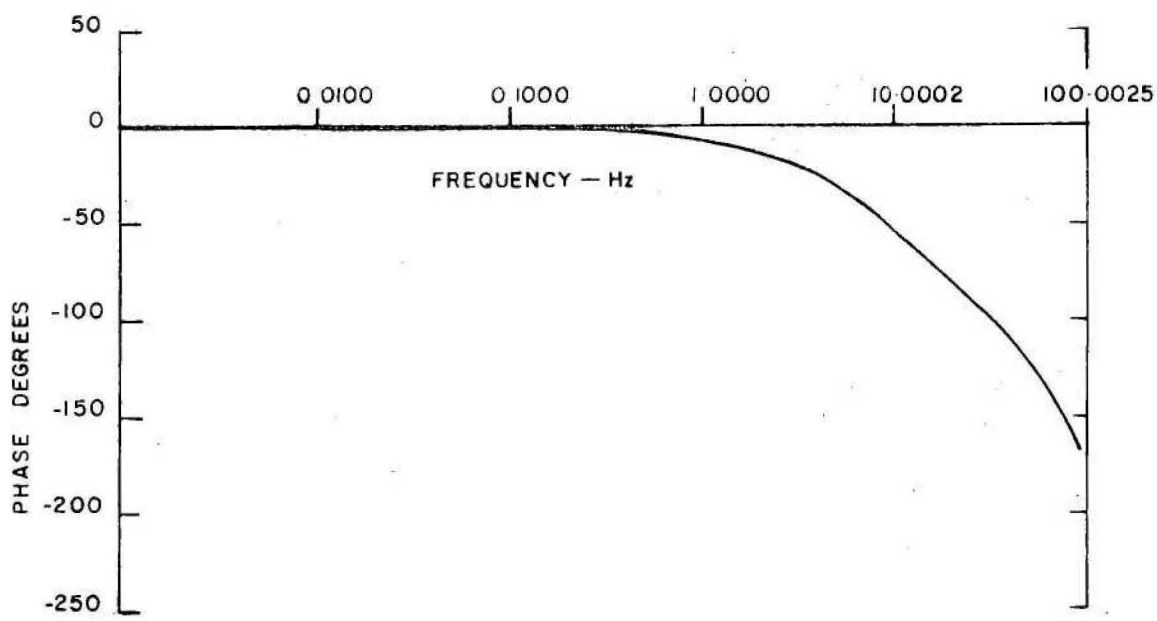
D(1) - AMPLITUDE PLOT THIRD-ORDER TRANSFER FUNCTION - B - = 10 Hz

D(2) - PHASE PLOT OF TRANSFER FUNCTION



10Hz BANDWIDTH

TRANSFER FUNCTION — AMPLITUDE RESPONSE



TRANSFER FUNCTION — PHASE RESPONSE

APPENDIX E

E(1) to E(8)	-	PROGRAM LISTINGS FOR 'ANØMALY' AND 'ERRPLØT'
E(9)	-	FLOWCHART FOR 'ANØMALY'
E(10)	-	FLOWCHART FOR 'ERRPLØT'

```
JOB    ,CCDMR*DA        ,ANOMAL61,,, LP02,,2345,,22/01/73
BEGIN JOB AT     233820 22/01/73
JOB,CCDMR*DA,ANOMALY4,        12
SIRO DAD 3.00 82/01/73
   ****************************************************************************
   ****************************************************************************
   **
   **  SOURCE INPUT FROM DR, NO CARD INPUT,
   **
   ****************************************************************************
   ****************************************************************************
EQUIP,60=SV
EQUIP,61=SV
EQUIP,61=CP
EQUIP,1=P_
EQUIP,62=SV
EQUIP,62=CP
PRLOCATE,20,,ANOMA62
DFCORDR,20,,ANOMA62
ABOVE CONTROL STATEMENT SKIPPED
EQUIP,20=SV
RTN,L,X
```

```
      PROGRAM ANOMALY
      COMPLEX POLE(24),ZERO(24),SUM1,SUM2,S
      DIMENSION FT(1000),F(1000),SIN(400),COS(400),SINT(400),COST(400)
     1,PHASE(400)
      DATA (POINTER=8HREADDATA)
   10 FORMAT(3(E15.8,4X),E15.8,8X)
      DO 20 I=1,1000
   20 FT(I)=F(I)=0.0
      READ 30,QINDEX
   30 FORMAT(A8)
      READ 50,NP,NZ
   50 FORMAT(I2,78X)
      READ 90,FUDGE
   90 FORMAT(F18.9)
      DO 60 I=1,NP
      READ 70,FIRST,FLAST
   60 POLE(I)=CMPLX(FIRST,FLAST)
   70 FORMAT(E15.8/E15.8)
      DO 80 I=1,NZ
      READ 70,FIRST,FLAST
   80 ZERO(I)=CMPLX(FIRST,FLAST)
      READ 10,COS,SIN
      IF(QINDEX.EQ.POINTER)READ(20,10)FT
      IF(QINDEX.EQ.POINTER)READ(20,10)F
      IF(QINDEX.EQ.POINTER)GO TO 500
      DO 200 J=1,400
  150 W=6.28318E-3*FLOATF(J-1)
      PHASE(J)=0.0
      SUM1=SUM2=(1.,0.)
      S=CMPLX(0.,W)
      IF(NZ.EQ.0)GO TO 170
      DO 160 I=1,NZ
      RL=S-ZERO(I)
      IF(RL.EQ.0.)RL=RL+10E-20
      PHASE(J)=PHASE(J)+ATAN(AIMAG(S-ZERO(I))/RL)
  160 SUM1=SUM1*(S-ZERO(I))
  170 IF(NP.EQ.0)GO TO 181
      DO 180 I=1,NP
      RL=S-POLE(I)
      IF(RL.EQ.0.)RL=RL+10E-20
      PHASE(J)=PHASE(J)-ATAN(AIMAG(S-POLE(I))/RL)
  180 SUM2=SUM2*(S-POLE(I))
  181 SUM1=SUM1/SUM2
      HW=CABS(SUM1)*FUDGE
      SINT(J)=SIN(J)*HW
      COST(J)=COS(J)*HW
  200 CONTINUE
      DO 312 M=1,11
      IF(M.NE.1)GO TO 302
      X=15.*6.28318E-3
      W1=-X
      I=1
      N2=28
  302 IF(M.NE.2)GO TO 303
      X=5.*6.28318E-3
      N2=35
  303 IF(M.NE.3)GO TO 304
      X=6.28318E-3
      N2=55
  304 IF(M.NE.4)GO TO 305
```

```
      X=6.28318E-3/5.
      N2=130
  305 IF(M.NE.5)GO TO 306
      X=6.28318E-4
      N2=280
  306 IF(M.NE.6)GO TO 307
      X=6.28318E-4/2.
      N2=680
  307 IF(M.NE.7)GO TO 308
      X=6.28318E-4
      N2=830
  308 IF(M.NE.8)GO TO 309
      X=6.28318E-3/5.
      N2=905
  309 IF(M.NE.9)GO TO 310
      X=6.28318E-3
      N2=925
  310 IF(M.NE.10)GO TO 311
      X=9.*6.28318E-3
      N2=932
  311 IF(M.NE.11)GO TO 300
      X=15.*6.28318E-3
      N2=958
  300 W1=W1+X
      J=1
  313 W=W1+FLOATF(J-1)
      FT(I)=FT(I)+SIN(J)*SINF(W)+COSF(W)*COS(J)
      F(I)=F(I)+SINT(J)*SINF(W+PHASE(J))+COSF(W+PHASE(J))*COST(J)
      J=J+1
      IF(J.LE.400)GO TO 313
      I=I+1
      IF(I.LE.N2)GO TO 300
  312 CONTINUE
      PUNCH 10,FT
      PUNCH 10,F
  500 PRINT 400,FT
      PRINT 400,F
  400 FORMAT(*1*,62(8F9.1/),4F9.1/)
      CALL ERRPLOT(F,FT)
      CALL EXIT
      END
```

```
      SUBROUTINE ERRPLOT(F,FT)
      DIMENSION F(1000),FT(1000)
      DATA (XAXIS=8HSECONDS.),(YAXIS1=7HGAMMAS.),(YAXIS2=8HPERCENT.)
      CALL PLOT(1.0,1.0,2)
      CALL PLOT(0.0,10.0,4)
      CALL PLOT(0.0,15.0,3)
      CALL PLOT(0.0,25.0,4)
      CALL PLOT(0.0,20.0,4)
      CALL PLOT(10.0,20.0,4)
      CALL PLOT(10.0,5.0,3)
      CALL PLOT(0.0,5.0,4)
      CALL PLOT(0.2,4.7,3)
      X=0.05
      Y=4.7
      DO 120 M=1,2
      DO 100 I=100,1000,100
      CALL PLOT(X,Y,3)
      IX=I-600
      ENCODE(4,110,IHAR)IX
  110 FORMAT(I4)
      CALL TEXT(IHAR,4,1)
      X=X+1.
  100 CONTINUE
      X=.05
      Y=19.7
  120 CONTINUE
      Y=0.0
      CALL PLOT(-0.4,0.0,3)
      DO 200 I=20,220,20
      K=I-120
      ENCODE(2,110,IHAR)K
      Y=Y+1.
      CALL TEXT(IHAR,4,1)
  200 CALL PLOT(-0.4,Y,3)
      Y=15.0
      DO 300 I=20,220,20
      CALL PLOT(-0.4,Y,3)
      K=I-120
      ENCODE(4,110,IHAR)K
      CALL TEXT(IHAR,4,1)
  300 Y=Y+1.
      CALL PLOT(0.3,19.6,3)
      CALL TEXT(XAXIS,8,2)
      CALL PLOT(0.3,4.6,3)
      CALL TEXT(XAXIS,8,2)
      CALL PLOT(-0.4,4.8,3)
      CALL TEXT(YAXIS1,-7,1)
      CALL PLOT(-0.4,19.8,3)
      CALL TEXT(YAXIS2,-8,1)
      CALL PLOT(0.0,5.0,3)
      CALL PLOT(0.0,0.0,1)
      INDEX=0
    8 Y=0.15
      X=-Y
      DO 1 I=1,958
      X=X+Y
      IF(INDEX.EQ.0)F(I)=(FT(I)-F(I))/20.
   12 IF(INDEX.EQ.1)FT(I)=100.*F(I)/FT(I)
   13 IF(INDEX.EQ.0)CALL PLOT(X,F(I),4)
    9 IF(INDEX.NE.0)CALL PLOT(X,FT(I),4)
```

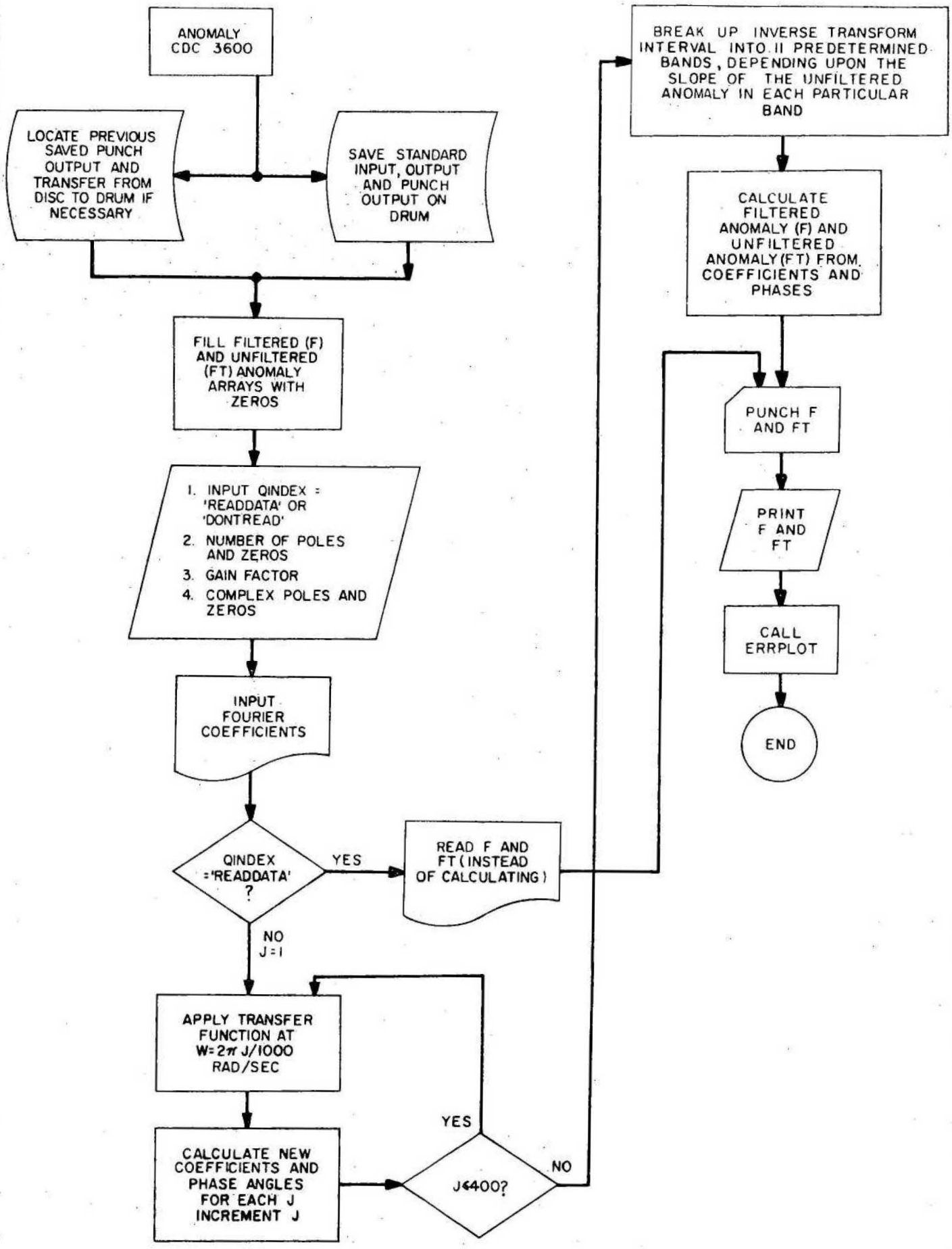
```
    3 IF((I.EQ.28).OR.(I.EQ.925))Y=0.05
    4 IF((I.EQ.35).OR.(I.EQ.905))Y=0.01
    5 IF((I.EQ.55).OR.(I.EQ.830))Y=0.002
    6 IF((I.EQ.130).OR.(I.EQ.680))Y=0.001
    7 IF(I.EQ.280)Y=0.0005
   10 IF(I.EQ.932)Y=0.15
    1 CONTINUE
      INDEX=INDEX+1
      IF(INDEX.GE.2)RETURN
   11 CALL PLOT(0.0,15.0,3)
      CALL PLOT(0.0,0.0,1)
      GO TO 8
      END
```

```
SCOPE
MEMORY AVAILABLE  17571₁₀
LOAD
RUN,12,5000

EXECUTION STARTED AT 090304
```

DRCORDF,62,CCDMR*DA,ANDMA62

```
LUN TYPE SECTORS CHARGE  SERIAL (MT)        LABEL
 68  DR       2
 62  DR      23                            CCDMR*DA ANOMA62
 60  DR      12                            CCDMR*DA ANOMALY
 20  DR      21                            CCDMR*DA ANOMA62
  1  PL       5       20
 61  LP      16        8
JOB,CCDMR*DA, ANOMALY,          END JOB 092241 CPU TIME, 0H 8M 7S  CHARGE,
```

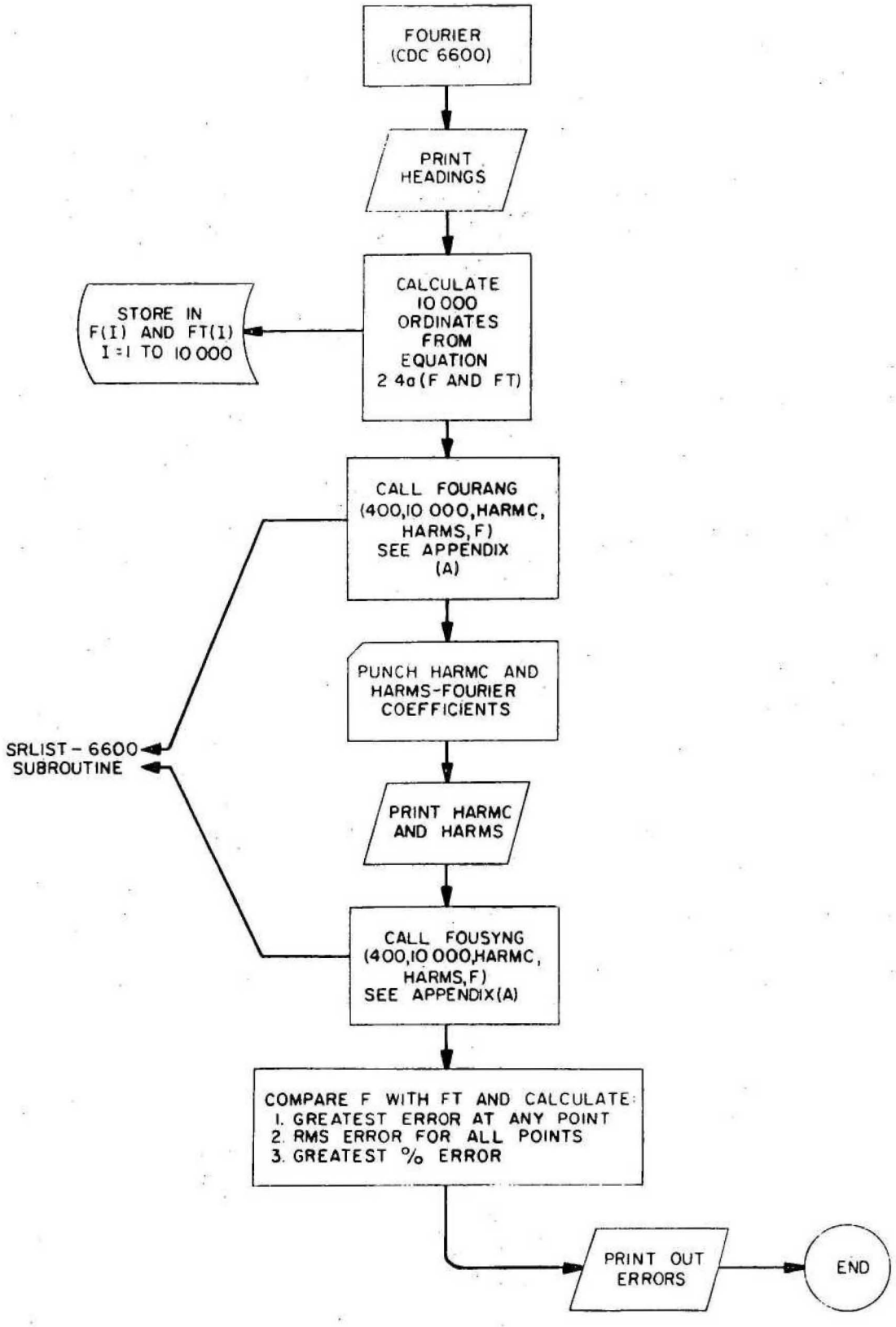


FLOWCHART FOR ANOMALY

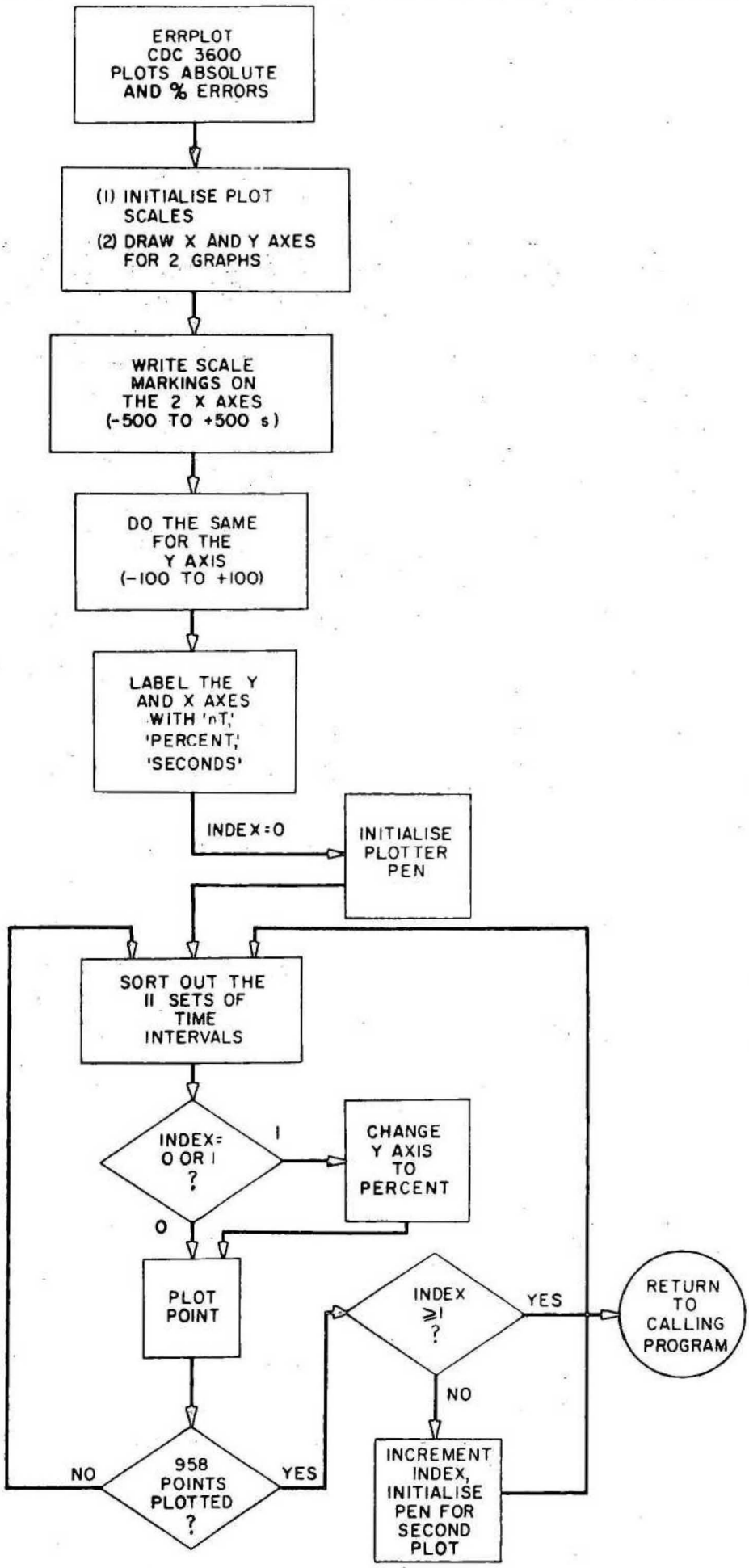
Record No. 1975/2

G43-534A

FLOWCHART FOR FØURIER



FLOWCHART FOR FOURIER



FLOWCHART FOR ERRPLOT

Record No. 1975/2

G43-535A

APPENDIX F

F(1) - G(2)		UNFILTERED ANOMALY = MAGNETOMETER INPUT
F(3) - (6)	-	1 Hz BANDWIDTH
F(7) - (10)	-	2 Hz BANDWIDTH
F(11) - (14)	-	5 Hz BANDWIDTH
F(15) - (18)	-	10 Hz BANDWIDTH
F(19) - (22)	-	20 Hz BANDWIDTH
F(23) - (26)	-	50 Hz BANDWIDTH
F(27) - (28)	-	100 Hz BANDWIDTH - PLOTS ONLY

F1

ANOMALY - UNFILTERED

-0.1	-0.4	-0.4	-0.4	-0.4	-0.5	-0.4	-0.5
-0.6	-0.5	-0.6	-0.7	-0.7	-0.7	-0.9	-0.9
-0.9	-1.2	-1.2	-1.3	-1.6	-1.9	-2.1	-2.6
-3.1	-3.8	-4.9	-6.6	-7.2	-8.1	-9.0	-10.3
-11.6	-13.4	-15.6	-16.5	-16.0	-18.0	-17.3	-18.3
-19.6	-19.0	-21.1	-20.8	-22.0	-23.3	-22.9	-25.6
-25.2	-26.6	-28.5	-28.2	-31.2	-31.2	-33.2	-34.0
-34.7	-35.2	-35.5	-35.5	-35.3	-35.1	-34.9	-35.0
-35.3	-36.0	-36.8	-37.7	-38.6	-39.3	-39.8	-40.0
-40.0	-39.8	-39.6	-39.6	-39.8	-40.4	-41.2	-42.1
-43.1	-44.0	-44.7	-45.1	-45.3	-45.2	-45.1	-45.1
-45.3	-45.8	-46.6	-47.6	-48.7	-49.8	-50.7	-51.4
-51.7	-51.7	-51.7	-51.6	-51.8	-52.2	-53.0	-54.1
-55.4	-56.8	-58.0	-58.9	-59.5	-59.8	-59.9	-59.8
-59.9	-60.3	-61.0	-62.1	-63.5	-65.1	-66.6	-67.9
-68.9	-69.5	-69.8	-70.0	-70.1	-70.5	-71.2	-72.3
-73.8	-75.6	-76.5	-77.4	-78.3	-79.1	-79.8	-80.4
-81.0	-81.4	-81.8	-82.1	-82.3	-82.4	-82.6	-82.7
-82.9	-83.2	-83.5	-84.0	-84.5	-85.2	-86.0	-86.8
-87.8	-88.9	-89.9	-91.0	-92.1	-93.2	-94.2	-95.1
-95.9	-96.6	-97.1	-97.6	-98.0	-98.3	-98.5	-98.8
-99.0	-99.3	-99.7	-100.2	-100.7	-101.5	-102.3	-103.3
-104.4	-105.6	-106.9	-108.2	-109.6	-111.0	-112.3	-113.5
-114.6	-115.7	-116.6	-117.4	-118.0	-118.6	-119.0	-119.5
-119.9	-120.3	-120.7	-121.3	-121.9	-122.7	-123.6	-124.7
-125.9	-127.3	-128.8	-130.3	-132.0	-133.7	-135.3	-136.9
-138.5	-139.9	-141.2	-142.4	-143.4	-144.3	-145.1	-145.8
-146.4	-147.0	-147.6	-148.3	-149.1	-150.0	-151.0	-152.3
-153.7	-155.2	-156.9	-158.8	-160.8	-162.8	-164.9	-166.9
-168.9	-170.7	-172.5	-174.1	-175.5	-176.8	-177.9	-178.8
-179.7	-180.5	-181.3	-182.1	-182.9	-183.9	-185.0	-186.3
-187.8	-189.5	-191.4	-193.4	-195.7	-198.0	-200.4	-202.8
-205.1	-207.4	-209.5	-211.4	-213.1	-214.6	-215.9	-217.0
-217.8	-218.5	-219.1	-219.7	-220.2	-220.8	-221.5	-222.3
-223.3	-224.5	-225.9	-227.5	-229.2	-231.1	-233.0	-234.9
-235.8	-236.7	-237.6	-238.5	-239.2	-239.9	-240.6	-241.2
-241.6	-242.0	-242.3	-242.5	-242.6	-242.7	-242.6	-242.4
-242.1	-241.7	-241.2	-240.6	-239.9	-239.2	-238.3	-237.4
-236.5	-235.5	-234.4	-233.3	-232.2	-231.1	-229.9	-228.7
-227.5	-226.3	-225.1	-223.9	-222.7	-221.5	-220.3	-219.0
-217.8	-216.5	-215.2	-213.8	-212.4	-210.9	-209.3	-207.7
-205.9	-204.0	-202.0	-199.8	-197.5	-194.9	-192.2	-189.2
-186.0	-182.6	-178.9	-174.9	-170.7	-166.2	-161.3	-156.2
-150.7	-144.9	-138.8	-132.3	-125.5	-118.4	-110.9	-103.1
-95.0	-86.5	-77.7	-68.6	-59.1	-49.2	-39.1	-28.6
-17.7	-6.5	5.1	17.0	29.4	42.1	55.3	68.9
82.9	97.5	112.5	128.1	144.3	161.1	178.5	196.6
215.5	235.1	255.5	276.9	299.1	322.3	346.5	371.8
398.2	425.8	454.6	484.7	516.1	548.9	583.2	618.9
656.2	695.0	735.5	777.7	821.6	867.3	914.9	964.3
1015.6	1068.9	1124.2	1181.6	1241.2	1302.9	1366.9	1433.1
1501.7	1572.8	1646.3	1722.4	1801.1	1882.5	1966.8	2053.9
2143.9	2237.1	2333.3	2432.9	2535.7	2642.0	2751.9	2865.3
2982.6	3103.6	3228.6	3357.7	3490.8	3628.1	3769.8	3915.7
4066.0	4220.8	4380.0	4543.8	4712.0	4884.6	5061.8	5243.3
5429.1	5619.2	5813.4	6011.5	6213.5	6419.1	6628.2	6840.4
7055.6	7273.5	7493.7	7715.9	7939.9	8165.1	8391.2	8617.8
8844.5	9070.9	+9296.3	9520.5	9742.8	9962.8	10180.0	10394.0
10604.0	10809.8	11010.7	11206.3	11396.1	11579.7	11756.4	11926.0
12087.9	12241.9	12387.4	12524.1	12651.8	12770.1	12878.8	12977.5
13066.2	13144.6	13212.6	13270.1	13317.1	13353.5	13379.4	13394.8
13399.7	13394.3	13378.8	13353.3	13318.0	13273.2	13219.2	13156.1
13084.5	13004.5	12916.6	12821.1				

F2 ANOMALY 2 OF 2

12718.4	12608.9	12493.1	12371.3	12243.9	12111.4	11974.2	11832.
11687.4	11538.6	11386.8	11232.3	11075.6	10916.9	10756.8	10595.4
10433.2	10270.3	10107.3	9944.2	9781.4	9619.1	9457.5	9296.8
9137.2	8978.9	8822.0	8666.7	8513.0	8361.1	8211.1	8062.9
7916.8	7772.7	7630.8	7490.9	7353.2	7217.6	7084.2	6952.9
6823.8	6696.9	6572.1	6449.5	6328.9	6210.5	6094.2	5979.9
5867.7	5757.5	5649.4	5543.2	5439.0	5336.8	5236.6	5138.3
5041.9	4947.5	4854.9	4764.3	4675.5	4588.5	4503.5	4420.2
4338.7	4259.1	4181.2	4105.1	4030.7	3958.0	3887.0	3817.6
3749.9	3683.7	3619.1	3556.0	3494.5	3434.3	3375.6	3318.2
3262.2	3207.4	3153.9	3101.6	3050.4	3000.4	2951.5	2903.6
2856.6	2810.7	2765.7	2721.5	2678.3	2635.8	2594.2	2553.3
2513.2	2473.8	2435.2	2397.2	2359.9	2323.3	2287.3	2252.0
2217.3	2183.3	2149.8	2117.0	2084.8	2053.3	2022.3	1991.9
1962.2	1933.1	1904.5	1876.6	1849.2	1822.5	1796.3	1770.7
1745.7	1721.2	1697.3	1673.9	1651.0	1628.7	1606.8	1585.5
1564.5	1544.1	1524.0	1504.4	1485.2	1466.3	1447.8	1429.7
1411.8	1394.3	1377.0	1360.1	1343.3	1326.9	1310.6	1294.6
1278.8	1263.2	1247.8	1232.5	1217.5	1202.6	1187.9	1173.4
1159.1	1145.0	1131.0	1117.3	1103.7	1090.3	1077.1	1064.1
1051.4	1038.8	1026.5	1014.3	1002.4	990.8	979.3	968.1
957.1	946.4	935.9	925.6	915.5	905.7	896.0	886.6
877.4	868.4	859.5	850.9	834.0	817.7	802.0	786.6
771.6	756.9	742.5	728.2	714.1	700.1	686.3	672.7
659.3	646.2	633.3	620.8	608.7	597.1	585.9	575.1
564.8	555.0	545.7	536.7	528.2	519.9	512.0	504.2
496.6	489.1	481.6	474.2	466.7	459.3	451.8	444.3
436.9	429.4	422.1	414.9	407.9	401.1	394.5	388.2
382.2	376.5	371.1	365.9	361.1	356.4	351.9	347.6
343.4	339.2	335.0	330.8	326.6	322.3	317.9	313.4
308.9	304.4	299.9	295.3	290.9	286.5	282.3	278.3
274.4	270.7	267.3	264.0	261.0	258.1	255.4	252.8
250.3	247.9	245.4	242.9	240.4	237.8	235.1	232.3
229.4	226.5	223.5	220.4	217.4	214.4	211.5	208.6
205.9	203.4	201.0	198.7	196.7	194.8	193.0	191.4
189.8	188.3	186.8	185.3	183.8	182.2	180.5	178.8
176.9	174.9	172.9	170.8	168.6	166.5	164.3	162.2
160.2	158.3	156.5	154.8	153.2	151.8	150.6	149.4
148.4	147.4	146.4	145.5	144.6	143.6	142.6	141.4
140.2	138.9	137.5	136.0	134.5	132.9	131.3	129.7
128.2	126.7	125.3	124.0	122.8	121.7	120.7	119.8
119.1	118.4	117.1	115.9	114.5	112.8	110.8	108.5
106.1	103.6	101.4	99.5	98.1	97.0	96.1	95.4
94.6	93.5	92.1	90.4	88.5	86.5	84.5	82.9
81.6	80.7	80.0	79.6	79.2	78.6	77.7	76.5
75.0	73.4	71.8	70.3	69.1	68.2	67.7	67.3
67.1	66.7	66.2	65.4	64.3	63.0	61.7	60.4
59.3	58.5	58.0	57.7	57.6	57.4	57.1	56.6
55.8	54.8	53.6	52.4	51.4	50.6	50.1	49.9
49.8	49.8	49.7	49.5	48.9	48.2	47.2	46.1
45.1	44.3	43.7	43.4	43.4	42.6	38.7	38.3
35.8	33.9	33.5	30.4	30.6	28.6	27.0	27.1
24.6	24.9	23.2	22.2	22.4	20.1	20.6	19.5
18.5	15.6	13.4	11.5	10.2	8.8	7.9	7.0
5.1	4.0	3.1	2.4	2.1	1.7	1.4	1.3
1.0	0.8	0.8	0.7	0.5	0.6	0.5	0.4
0.4	0.4	0.2	0.3	0.3	0.2	0.2	0.2
0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0				

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0,0	-0,4	-0,4	-0,3	-0,4	-0,5	-0,4	-0,4
-0,6	-0,5	-0,5	-0,7	-0,6	-0,7	-0,8	-0,8
-0,9	-1,1	-1,2	-1,3	-1,5	-1,8	-2,0	-2,5
-3,0	-3,7	-4,3	-6,4	-7,2	-7,9	-8,6	-10,0
-11,4	-13,1	-15,3	-16,6	-15,9	-17,7	-17,5	-18,0
-19,5	-19,9	-20,8	-21,0	-21,6	-23,4	-22,8	-25,2
-25,4	-26,0	-27,5	-28,1	-30,5	-31,3	-32,6	-33,4
-34,2	-34,0	-34,5	-35,4	-35,4	-35,2	-35,1	-35,0
-35,1	-35,5	-36,2	-37,0	-37,9	-38,7	-39,4	-39,8
-39,9	-39,9	-39,3	-39,7	-39,7	-40,0	-40,6	-41,4
-42,3	-43,3	-44,1	-44,8	-45,1	-45,2	-45,2	-45,1
-45,2	-45,5	-46,0	-46,8	-47,9	-49,0	-50,0	-50,8
-51,4	-51,6	-51,7	-51,7	-51,7	-51,9	-52,5	-53,3
-54,4	-55,7	-57,0	-58,1	-59,0	-59,5	-59,8	-59,8
-59,9	-60,1	-60,5	-61,3	-62,5	-63,9	-65,4	-66,8
-68,0	-68,9	-69,5	-69,8	-70,0	-70,2	-70,7	-71,5
-72,7	-74,2	-75,1	-76,0	-76,8	-77,7	-78,5	-79,3
-80,0	-80,6	-81,1	-81,5	-81,8	-82,1	-82,3	-82,5
-82,6	-82,8	-83,1	-83,4	-83,8	-84,3	-84,9	-85,6
-86,4	-87,3	-88,3	-89,3	-90,4	-91,5	-92,5	-93,5
-94,4	-95,3	-95,0	-96,7	-97,2	-97,6	-98,0	-98,3
-98,6	-98,9	-99,2	-99,5	-100,0	-100,5	-101,2	-101,9
-102,8	-103,9	-105,0	-106,2	-107,5	-108,8	-110,1	-111,4
-112,7	-113,9	-114,9	-115,9	-116,8	-117,5	-118,1	-118,7
-119,1	-119,6	-120,0	-120,5	-121,0	-121,6	-122,3	-123,2
-124,2	-125,3	-126,6	-128,0	-129,5	-131,1	-132,7	-134,3
-135,9	-137,5	-138,9	-140,3	-141,5	-142,6	-143,6	-144,5
-145,2	-145,9	-146,6	-147,2	-147,9	-148,7	-149,6	-150,5
-151,7	-153,0	-154,5	-156,1	-157,8	-159,7	-161,7	-163,7
-165,7	-167,6	-169,5	-171,3	-173,0	-174,5	-175,8	-177,0
-178,1	-179,0	-179,9	-180,7	-181,6	-182,4	-183,4	-184,5
-185,7	-187,1	-188,7	-190,4	-192,4	-194,5	-196,7	-199,0
-201,3	-203,7	-206,9	-208,1	-210,1	-211,9	-213,5	-214,9
-216,1	-217,1	-217,9	-218,6	-219,3	-219,9	-220,5	-221,1
-221,9	-222,9	-224,0	-225,3	-226,7	-228,3	-230,1	-231,9
-232,9	-233,8	-234,7	-235,6	-236,5	-237,3	-238,1	-238,9
-239,5	-240,2	-240,7	-241,2	-241,6	-241,9	-242,1	-242,2
-242,2	-242,1	-241,9	-241,7	-241,3	-240,8	-240,3	-239,7
-238,9	-238,2	-237,3	-236,4	-235,4	-234,4	-233,4	-232,3
-231,2	-230,1	-228,9	-227,7	-226,6	-225,4	-224,2	-223,0
-221,8	-220,5	-219,3	-218,0	-216,7	-215,4	-214,0	-212,5
-211,0	-209,4	-207,7	-205,9	-204,0	-201,9	-199,7	-197,3
-194,7	-192,0	-189,0	-185,8	-182,3	-178,6	-174,7	-170,4
-165,9	-161,1	-155,9	-150,5	-144,8	-138,7	-132,3	-125,5
-118,5	-111,1	-103,4	-95,3	-86,9	-78,2	-69,1	-59,7
-49,9	-39,9	-29,4	-18,6	-7,5	4,1	16,0	28,3
41,0	54,1	67,7	81,7	96,3	111,3	126,9	143,1
159,9	177,3	195,5	214,3	234,0	254,4	275,8	298,0
321,2	345,4	370,7	397,1	424,7	453,4	483,5	514,8
547,6	581,7	617,4	654,5	693,3	733,6	775,6	819,4
864,9	912,2	961,4	1012,5	1065,6	1120,7	1177,9	1237,1
1298,6	1362,3	1428,3	1496,6	1567,4	1640,5	1716,5	1794,9
1876,0	1960,0	2046,8	2136,6	2229,4	2325,3	2424,5	2527,1
2633,0	2742,5	2855,6	2972,4	3093,0	3217,5	3346,1	3478,7
3615,4	3756,4	3901,7	4051,3	4205,2	4363,6	4526,4	4693,6
4865,2	5041,2	5221,5	5406,1	5594,8	5787,6	5984,2	6184,6
6388,6	6595,0	6806,5	7019,8	7235,5	7454,1	7674,4	7895,3
8119,6	8343,7	8568,3	8793,0	9017,3	9240,8	9463,1	9683,5
9901,8	10117,3	10325,5	10538,1	10742,5	10942,1	11136,6	11325,4
11508,0	11684,1	11853,2	12014,8	12169,6	12314,2	12451,2	12579,3
12698,2	12807,7	12907,5	12997,5	13077,3	13147,0	13206,4	13255,4
13294,1	13322,3	13340,2	13347,9	13345,3	13332,8	13310,4	13278,3
13236,8	13186,1	13125,5	13058,3				

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	12981,9	12897,5	12805,6	12706,4	12600,4	12483,0	12369,6	12245,5
	12116,4	11982,4	11844,9	11701,7	11555,8	11406,7	11254,9	11100,6
	10944,3	10786,3	10627,0	10466,7	10305,6	10144,2	9982,6	9821,1
1	9659,9	9499,4	9339,5	9180,8	9023,1	8866,7	8711,8	8558,4
2	8408,7	8256,7	8108,5	7962,4	7818,2	7676,0	7535,8	7397,8
3	7261,8	7128,0	6996,2	6866,7	6739,2	6613,9	6490,7	6369,6
4	6250,6	6133,7	6018,8	5906,0	5795,3	5686,5	5579,8	5475,1
5	5372,3	5271,5	5172,6	5075,7	4980,7	4887,6	4796,4	4707,1
6	4619,6	4534,0	4450,2	4368,2	4288,0	4209,6	4133,0	4058,0
7	3984,8	3913,2	3843,3	3775,1	3708,4	3643,2	3579,6	3517,5
8	3456,8	3397,5	3339,5	3283,1	3227,8	3173,8	3121,0	3069,3
9	3018,8	2969,4	2921,0	2873,7	2827,3	2781,9	2737,3	2693,7
10	2650,9	2608,9	2567,7	2527,2	2487,6	2448,6	2410,4	2372,8
11	2335,9	2299,7	2264,2	2229,3	2195,0	2161,4	2128,4	2096,1
12	2064,3	2033,2	2002,6	1972,7	1943,4	1914,7	1886,6	1859,1
13	1832,2	1805,8	1780,1	1754,9	1730,2	1706,1	1682,5	1659,5
14	1636,9	1614,9	1593,3	1572,2	1551,6	1531,3	1511,5	1492,1
15	1473,1	1454,4	1436,1	1418,1	1400,4	1382,9	1365,8	1349,0
16	1332,4	1316,0	1299,9	1283,9	1268,2	1252,7	1237,4	1222,3
17	1207,3	1192,6	1178,0	1163,7	1149,5	1135,5	1121,7	1108,1
18	1094,6	1081,4	1068,4	1055,6	1043,0	1030,6	1018,5	1006,5
19	994,8	983,3	972,1	961,1	950,3	939,7	929,3	919,2
20	909,3	899,6	890,1	880,8	862,7	845,4	828,7	812,5
21	796,8	781,5	766,6	751,9	737,4	723,1	709,1	695,2
22	681,4	667,9	654,7	641,7	629,0	616,7	604,8	593,4
23	582,4	571,8	561,7	552,1	542,9	534,0	525,5	517,3
24	509,4	501,6	494,0	486,4	478,9	471,4	464,0	456,5
25	449,0	441,6	434,1	426,8	419,6	412,5	405,6	398,9
26	392,5	386,3	380,4	374,8	369,5	364,4	359,6	355,0
27	350,5	346,2	341,9	337,7	333,5	329,2	324,9	320,6
28	316,2	311,7	307,2	302,7	298,2	293,7	289,4	285,1
29	281,0	277,0	273,3	269,7	266,3	263,2	260,2	257,3
30	254,6	252,0	249,5	247,0	244,5	242,0	239,4	236,7
31	234,0	231,1	228,3	225,3	222,3	219,3	216,3	213,4
32	210,5	207,8	205,1	202,7	200,3	198,2	196,2	194,3
33	192,6	190,9	189,3	187,8	186,3	184,8	183,2	181,5
34	179,8	178,0	176,1	174,1	172,0	169,9	167,8	165,7
35	163,6	161,5	159,5	157,7	156,0	154,4	152,9	151,5
36	150,3	149,2	148,1	147,1	146,2	145,2	144,2	143,2
37	142,1	140,9	139,5	138,3	136,9	135,4	133,9	132,3
38	130,7	129,2	127,7	126,2	124,9	123,6	122,5	121,4
39	120,5	119,7	118,2	116,9	115,6	114,2	112,4	110,3
40	108,0	105,6	103,2	101,1	99,3	98,0	96,9	96,1
41	95,3	94,3	93,2	91,7	90,0	88,1	86,1	84,3
42	82,7	81,5	80,5	80,0	79,5	79,0	78,3	77,4
43	76,2	74,7	73,1	71,5	70,1	69,0	68,2	67,7
44	67,3	67,0	66,6	66,0	65,1	64,0	62,8	61,4
45	60,2	59,2	58,5	58,0	57,7	57,6	57,4	57,0
46	56,4	55,5	54,5	53,4	52,2	51,3	50,6	50,1
47	49,9	49,8	49,8	49,7	49,3	48,7	47,9	47,0
48	45,9	45,0	44,3	43,8	43,5	43,0	39,2	38,3
49	36,4	33,9	33,8	30,8	30,5	29,1	27,0	27,3
50	24,9	24,8	23,7	22,2	22,6	20,4	20,5	19,8
51	18,4	15,5	13,3	11,4	10,1	8,8	7,9	6,9
52	5,1	4,0	3,0	2,4	2,1	1,7	1,3	1,2
53	1,0	0,8	0,8	0,7	0,5	0,6	0,5	0,4
54	0,4	0,4	0,3	0,3	0,3	0,2	0,2	0,3
55	0,2	0,1	0,0	0,0	0,0	0,0	0,0	0,0
56	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
57	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
58	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
59	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
60	0,0	0,0	0,0	0,0				

F7

2 Hz B-W

	-0,0	-0,4	-0,4	-0,3	-0,4	-0,5	-0,4	-0,5
	-0,6	-0,5	-0,5	-0,7	-0,6	-0,7	-0,9	-0,9
	-0,9	-1,1	-1,2	-1,3	-1,6	-1,8	-2,0	-2,5
1	-3,1	-3,7	-4,9	-6,5	-7,1	-8,0	-8,9	-10,1
2	-11,5	-13,3	-15,5	-16,6	-15,9	-17,8	-17,4	-18,1
3	-19,6	-18,9	-21,0	-20,9	-21,8	-23,4	-22,8	-25,4
4	-25,3	-26,4	-28,5	-28,1	-31,0	-31,3	-32,9	-33,7
5	-34,4	-35,2	-35,4	-35,5	-35,4	-35,2	-35,0	-35,0
6	-35,2	-35,7	-36,4	-37,3	-38,2	-39,0	-39,6	-39,9
7	-40,0	-39,9	-39,7	-39,6	-39,7	-40,1	-40,8	-41,7
8	-42,7	-43,7	-44,5	-45,0	-45,2	-45,3	-45,2	-45,1
9	-45,2	-45,6	-45,2	-47,2	-48,3	-49,4	-50,4	-51,1
10	-51,6	-51,7	-51,7	-51,7	-51,7	-52,0	-52,7	-53,7
11	-54,9	-56,2	-57,5	-58,6	-59,3	-59,7	-59,8	-59,8
12	-59,9	-60,1	-60,7	-61,7	-62,9	-64,4	-66,0	-67,4
13	-68,5	-69,3	-69,7	-69,9	-70,1	-70,3	-70,9	-71,9
14	-73,2	-74,9	-75,7	-76,6	-77,5	-78,4	-79,2	-79,9
15	-80,5	-81,0	-81,5	-81,8	-82,1	-82,3	-82,5	-82,6
16	-82,8	-83,0	-83,3	-83,6	-84,1	-84,7	-85,3	-86,1
17	-87,0	-88,0	-89,1	-90,1	-91,2	-92,3	-93,4	-94,3
18	-95,2	-96,0	-96,6	-97,2	-97,6	-98,0	-98,3	-98,6
19	-98,8	-99,1	-99,4	-99,8	-100,3	-100,9	-101,6	-102,5
20	-103,5	-104,6	-105,9	-107,1	-108,5	-109,8	-111,2	-112,5
21	-113,7	-114,8	-115,6	-116,7	-117,4	-118,1	-118,6	-119,1
22	-119,5	-119,9	-120,4	-120,8	-121,4	-122,1	-122,9	-123,8
23	-124,9	-126,2	-127,6	-129,1	-130,7	-132,3	-134,0	-135,6
24	-137,2	-138,7	-140,1	-141,4	-142,5	-143,5	-144,4	-145,2
25	-145,9	-146,5	-147,1	-147,8	-148,5	-149,3	-150,2	-151,3
26	-152,5	-154,0	-155,6	-157,3	-159,2	-161,2	-163,2	-165,2
27	-167,2	-169,2	-171,0	-172,7	-174,3	-175,7	-176,9	-178,0
28	-179,0	-179,8	-180,5	-181,4	-182,2	-183,1	-184,1	-185,3
29	-186,6	-188,1	-189,9	-191,8	-193,9	-196,1	-198,4	-200,8
30	-203,2	-205,5	-207,7	-209,8	-211,7	-213,3	-214,8	-216,0
31	-217,1	-217,9	-218,6	-219,2	-219,8	-220,3	-220,9	-221,7
32	-222,5	-223,6	-224,8	-226,2	-227,8	-229,6	-231,4	-233,3
33	-234,3	-235,2	-236,1	-237,0	-237,9	-238,7	-239,4	-240,1
34	-240,7	-241,2	-241,7	-242,0	-242,3	-242,5	-242,5	-242,5
35	-242,4	-242,1	-241,8	-241,4	-240,8	-240,2	-239,5	-238,8
36	-237,9	-237,0	-236,1	-235,1	-234,0	-232,9	-231,8	-230,6
37	-229,5	-228,3	-227,1	-225,9	-224,7	-223,5	-222,3	-221,0
38	-219,8	-218,6	-217,3	-216,0	-214,6	-213,2	-211,8	-210,3
39	-208,7	-206,9	-205,1	-203,2	-201,1	-198,8	-196,4	-193,7
40	-190,9	-187,9	-184,6	-181,0	-177,2	-173,1	-168,8	-164,1
41	-159,1	-153,9	-148,3	-142,3	-136,1	-129,5	-122,6	-115,4
42	-107,8	-99,9	-91,6	-83,0	-74,1	-64,8	-55,2	-45,3
43	-35,0	-24,3	-13,4	-2,0	9,7	21,8	34,3	47,2
44	60,6	74,3	88,6	103,3	118,6	134,5	150,9	167,9
45	185,7	204,1	223,3	243,2	264,0	285,7	308,3	332,0
46	356,6	382,4	409,2	437,3	466,7	497,3	529,2	562,6
47	597,5	633,8	671,7	711,2	752,3	795,2	839,8	886,2
48	934,4	984,6	1036,6	1090,7	1146,8	1205,1	1265,4	1328,0
49	1392,8	1460,0	1529,5	1601,5	1676,0	1753,1	1832,9	1915,4
50	2000,8	2089,0	2180,2	2274,6	2372,1	2472,9	2577,1	2684,8
51	2796,0	2910,9	3029,6	3152,2	3278,7	3409,3	3544,0	3683,0
52	3826,2	3973,8	4125,7	4282,1	4443,0	4608,3	4778,0	4952,3
53	5130,9	5313,9	5501,1	5692,5	5888,0	6087,3	6290,4	6497,0
54	6706,9	6919,9	7135,8	7354,1	7574,7	7797,1	8021,1	8246,2
55	8472,0	8698,2	8924,3	9149,8	9374,2	9597,2	9818,1	10036,6
56	10252,0	10464,0	10672,0	10875,5	11073,9	11266,9	11453,9	11634,5
57	11808,2	11974,6	12133,2	12283,7	12425,7	12558,9	12682,9	12797,4
58	12902,3	12997,2	13082,0	13156,6	13220,7	13274,5	13317,7	13350,3
59	13372,5	13384,3	13385,7	13376,9	13358,0	13329,3	13290,9	13243,1
60	13186,2	13120,5	13046,3	12963,9				

F8

2Hz B-W

	12873,7	12776,1	12671,5	12560,3	12442,8	12319,5	12190,8	12057,1
	11918,9	11776,6	11630,5	11481,1	11328,9	11174,0	11017,1	10858,3
	10698,1	10536,9	10374,8	10212,2	10049,5	9886,8	9724,5	9562,7
1	9401,7	9241,6	9082,7	8925,1	8768,9	8614,3	8461,4	8310,3
2	8161,0	8013,7	7868,4	7725,1	7583,9	7444,8	7307,9	7173,1
3	7040,4	6909,9	6781,6	6655,4	6531,4	6409,5	6289,7	6172,0
4	6056,3	5942,8	5831,3	5721,8	5614,3	5508,8	5405,3	5303,8
5	5204,2	5106,6	5010,9	4917,1	4825,2	4735,2	4647,0	4560,7
6	4476,3	4393,6	4312,8	4233,7	4156,4	4080,9	4007,1	3934,9
7	3864,5	3795,6	3728,4	3662,8	3598,7	3536,1	3475,0	3415,3
8	3357,0	3300,1	3244,4	3190,1	3136,9	3085,0	3034,2	2984,5
9	2935,8	2888,2	2841,5	2795,9	2751,2	2707,3	2664,3	2622,1
10	2580,7	2540,1	2500,2	2461,1	2422,6	2384,9	2347,8	2311,4
11	2275,6	2240,5	2206,1	2172,2	2139,0	2106,4	2074,4	2043,1
12	2012,3	1982,2	1952,5	1923,7	1895,4	1867,7	1840,5	1814,0
13	1788,0	1762,6	1737,7	1713,4	1689,7	1666,5	1643,8	1621,6
14	1599,9	1578,6	1557,9	1537,5	1517,6	1498,1	1479,0	1460,2
15	1441,8	1423,8	1406,0	1388,6	1371,4	1354,5	1337,8	1321,4
16	1305,2	1289,3	1273,5	1258,0	1242,6	1227,4	1212,5	1197,7
17	1183,0	1168,6	1154,4	1140,3	1126,4	1112,7	1099,2	1085,9
18	1072,8	1059,9	1047,2	1034,7	1022,4	1010,4	998,6	987,0
19	975,7	964,5	953,5	943,0	932,5	922,3	912,3	902,5
20	893,0	883,6	874,4	865,5	856,1	831,3	815,1	799,4
21	784,1	769,1	754,4	740,0	725,7	711,6	697,7	683,9
22	670,4	657,0	644,0	631,2	618,8	606,8	595,2	584,1
23	573,4	563,2	553,5	544,2	535,3	526,8	518,6	510,6
24	502,9	495,3	487,8	480,3	472,9	465,4	457,9	450,5
25	443,0	435,6	428,2	420,9	413,7	406,7	400,0	393,5
26	387,2	381,3	375,5	370,2	365,1	360,3	355,7	351,2
27	346,9	342,6	338,4	334,3	330,1	325,8	321,5	317,1
28	312,6	308,1	303,6	299,1	294,6	290,1	285,8	281,6
29	277,6	273,8	270,2	266,8	263,6	260,6	257,7	255,0
30	252,4	249,9	247,4	245,0	242,5	239,9	237,3	234,6
31	231,8	228,9	226,3	222,9	219,9	216,9	213,9	211,0
32	208,2	205,5	203,0	200,6	198,4	196,4	194,5	192,8
33	191,1	189,6	188,1	186,6	185,1	183,5	181,9	180,2
34	178,4	176,5	174,5	172,5	170,4	168,2	166,1	164,0
35	161,9	159,9	158,0	156,2	154,5	153,0	151,7	150,4
36	149,3	148,2	147,2	146,3	145,4	144,4	143,4	142,3
37	141,2	140,0	138,6	137,2	135,8	134,2	132,6	131,1
38	129,5	127,9	126,5	125,1	123,8	122,6	121,5	120,6
39	119,7	119,0	117,6	116,4	115,1	113,6	111,7	109,5
40	107,1	104,6	102,3	100,3	98,6	97,4	96,5	95,7
41	94,9	94,0	92,7	91,1	89,3	87,3	85,3	83,6
42	82,1	81,0	80,3	79,8	79,3	78,8	78,1	77,0
43	75,6	74,1	72,5	70,9	69,6	68,6	67,9	67,5
44	67,2	66,9	66,4	65,7	64,8	63,6	62,2	60,9
45	59,7	58,8	58,2	57,8	57,6	57,5	57,3	56,8
46	56,1	55,2	54,1	52,9	51,8	50,9	50,3	49,9
47	49,8	49,8	49,8	49,6	49,2	48,5	47,6	46,6
48	45,5	44,6	44,0	43,6	43,4	42,8	38,9	38,3
49	36,1	33,9	33,7	30,5	30,5	28,9	27,0	27,2
50	24,8	24,8	23,5	22,2	22,5	20,3	20,6	19,6
51	18,4	15,5	13,3	11,4	10,1	8,8	7,9	7,0
52	5,1	4,0	3,0	2,4	2,1	1,7	1,3	1,2
53	1,0	0,8	0,8	0,7	0,5	0,6	0,5	0,4
54	0,4	0,4	0,2	0,3	0,3	0,2	0,2	0,2
55	0,1	0,1	0,0	0,0	0,0	0,0	0,0	0,0
56	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
57	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
58	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
59	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
60	0,0	0,0	0,0	0,0				

	-0,1	-0,4	-0,4	-0,3	-0,4	-0,5	-0,4	-0,5
	-0,6	-0,5	-0,6	-0,7	-0,7	-0,7	-0,9	-0,9
	-0,9	-1,1	-1,2	-1,3	-1,5	-1,8	-2,1	-2,6
1	-3,1	-3,8	-4,9	-6,5	-7,1	-8,1	-8,9	-10,2
2	-11,6	-13,4	-15,5	-16,5	-16,0	-17,9	-17,4	-18,3
3	-19,6	-19,0	-21,1	-20,8	-21,9	-23,4	-22,8	-25,5
4	-25,3	-26,5	-29,5	-28,2	-31,2	-31,2	-33,1	-33,9
5	-34,6	-35,2	-35,4	-35,5	-35,3	-35,1	-34,9	-35,0
6	-35,3	-35,8	-35,5	-37,5	-38,5	-39,2	-39,7	-40,0
7	-40,0	-39,8	-39,7	-39,6	-39,8	-40,3	-41,0	-42,0
8	-43,0	-43,9	-44,6	-45,1	-45,3	-45,3	-45,1	-45,1
9	-45,3	-45,7	-46,4	-47,4	-48,5	-49,6	-50,6	-51,3
10	-51,6	-51,7	-51,7	-51,6	-51,7	-52,1	-52,9	-53,9
11	-55,2	-56,5	-57,5	-58,8	-59,4	-59,8	-59,9	-59,8
12	-59,9	-60,2	-60,9	-61,9	-63,3	-64,8	-66,3	-67,7
13	-68,8	-69,4	-69,8	-70,0	-70,1	-70,4	-71,1	-72,1
14	-73,6	-75,3	-76,2	-77,1	-78,0	-78,8	-79,5	-80,2
15	-80,8	-81,3	-81,7	-82,0	-82,2	-82,4	-82,5	-82,7
16	-82,9	-83,1	-83,4	-83,8	-84,3	-84,9	-85,7	-86,5
17	-87,5	-88,5	-89,6	-90,7	-91,8	-92,8	-93,8	-94,8
18	-95,6	-96,3	-96,9	-97,4	-97,9	-98,2	-98,5	-98,7
19	-98,9	-99,2	-99,6	-100,0	-100,5	-101,2	-102,0	-102,9
20	-104,0	-105,2	-106,4	-107,8	-109,1	-110,5	-111,8	-113,1
21	-114,3	-115,3	-116,3	-117,1	-117,8	-118,4	-118,9	-119,3
22	-119,7	-120,1	-120,6	-121,1	-121,7	-122,4	-123,3	-124,3
23	-125,5	-126,8	-128,2	-129,8	-131,4	-133,1	-134,8	-136,4
24	-138,0	-139,4	-140,8	-142,0	-143,1	-144,0	-144,8	-145,5
25	-146,2	-146,8	-147,4	-148,1	-148,8	-149,7	-150,7	-151,8
26	-153,2	-154,7	-156,3	-158,2	-160,1	-162,1	-164,1	-166,2
27	-168,2	-170,1	-171,9	-173,5	-175,0	-176,3	-177,5	-178,5
28	-179,4	-180,2	-181,0	-181,8	-182,6	-183,5	-184,6	-185,8
29	-187,3	-188,9	-190,7	-192,7	-194,9	-197,2	-199,5	-201,9
30	-204,3	-206,6	-208,7	-210,7	-212,5	-214,1	-215,5	-216,6
31	-217,5	-218,3	-218,9	-219,5	-220,0	-220,6	-221,2	-222,0
32	-222,9	-224,1	-225,4	-226,9	-228,6	-230,4	-232,3	-234,2
33	-235,2	-236,1	-237,0	-237,9	-238,7	-239,4	-240,1	-240,7
34	-241,3	-241,7	-242,1	-242,4	-242,6	-242,6	-242,6	-242,5
35	-242,3	-241,9	-241,5	-241,0	-240,4	-239,7	-238,9	-238,1
36	-237,1	-236,2	-235,2	-234,1	-233,0	-231,9	-230,7	-229,5
37	-228,4	-227,2	-226,0	-224,8	-223,5	-222,3	-221,1	-219,9
38	-218,6	-217,4	-216,1	-214,7	-213,4	-211,9	-210,4	-208,8
39	-207,1	-205,3	-203,4	-201,3	-199,1	-196,7	-194,1	-191,3
40	-188,2	-185,0	-181,5	-177,7	-173,6	-169,3	-164,6	-159,7
41	-154,4	-148,9	-143,0	-136,8	-130,2	-123,3	-116,1	-108,5
42	-100,6	-92,4	-83,8	-74,9	-65,6	-56,0	-46,1	-35,8
43	-25,2	-14,3	-2,9	8,8	20,8	33,3	46,2	59,5
44	73,2	87,4	102,1	117,3	133,1	149,5	166,5	184,1
45	202,4	221,5	241,4	262,1	283,7	306,3	329,8	354,3
46	380,0	406,7	434,7	463,9	494,4	526,3	559,5	594,2
47	630,4	668,2	707,6	748,6	791,3	835,7	882,0	930,1
48	980,1	1032,1	1086,0	1142,0	1200,0	1260,2	1322,6	1387,3
49	1454,3	1523,6	1595,4	1669,8	1746,7	1826,2	1908,5	1993,6
50	2081,6	2172,6	2266,7	2364,0	2464,6	2568,5	2675,9	2786,8
51	2901,5	3019,9	3142,1	3268,4	3398,7	3533,1	3671,8	3814,7
52	3962,0	4113,7	4269,9	4430,4	4595,5	4765,1	4939,1	5117,6
53	5300,4	5487,5	5678,5	5874,2	6073,5	6276,6	6483,2	6693,2
54	6906,4	7122,3	7342,9	7561,7	7784,4	8008,7	8234,1	8460,4
55	8687,0	8913,5	9139,5	9364,5	9588,1	9809,7	10028,8	10244,9
56	10457,6	10666,3	10870,5	11069,8	11263,6	11451,5	11632,9	11807,4
57	11974,6	12134,0	12288,4	12428,2	12562,1	12686,9	12802,2	12907,8
58	13003,5	13089,0	13164,2	13229,0	13283,3	13327,1	13360,3	13383,0
59	13395,1	13396,9	13388,5	13369,9	13341,5	13303,3	13255,7	13199,0
60	13133,3	13059,2	12979,8	12886,6				

F12

5Hz B-W

	12789,0	12684,3	12572,9	12455,3	12331,8	12202,9	12069,0	11930,6
	11788,0	11641,6	11492,0	11339,4	11184,2	11027,0	10867,9	10707,4
	10545,8	10383,4	10220,5	10057,5	9894,5	9731,9	9569,8	9408,5
1	9248,2	9089,0	8931,2	8774,8	8620,0	8466,8	8315,5	8166,1
2	8018,6	7873,1	7729,7	7588,3	7449,1	7312,0	7177,1	7044,4
3	6913,8	6785,3	6659,0	6534,9	6412,9	6293,0	6175,2	6059,5
4	5945,9	5834,3	5724,7	5617,2	5511,6	5408,1	5306,5	5206,8
5	5109,1	5013,3	4919,5	4827,5	4737,4	4649,2	4562,8	4478,2
6	4395,5	4314,0	4235,5	4158,2	4082,6	4008,7	3936,5	3866,0
7	3797,1	3729,8	3664,2	3600,0	3537,4	3476,3	3416,5	3358,2
8	3301,3	3245,6	3191,2	3138,1	3086,1	3035,3	2985,6	2937,0
9	2889,4	2842,7	2797,1	2752,3	2708,4	2665,4	2623,2	2581,8
10	2541,2	2501,3	2462,1	2423,7	2385,9	2348,8	2312,4	2276,6
11	2241,5	2207,0	2173,1	2139,9	2107,3	2075,3	2043,9	2013,1
12	1982,9	1953,4	1924,4	1896,1	1868,3	1841,1	1814,6	1788,6
13	1763,1	1738,3	1714,0	1690,2	1667,0	1644,3	1622,1	1600,4
14	1579,1	1558,4	1538,0	1518,1	1498,6	1479,5	1460,7	1442,3
15	1424,3	1406,5	1389,1	1371,9	1355,0	1338,3	1321,9	1305,7
16	1289,8	1274,0	1258,5	1243,1	1228,0	1213,0	1198,2	1183,5
17	1169,1	1154,8	1140,8	1126,9	1113,1	1099,6	1086,3	1073,2
18	1060,3	1047,6	1035,1	1022,8	1010,7	998,9	987,3	975,9
	964,8	953,9	943,2	932,8	922,5	912,5	902,8	893,2
	883,8	874,7	865,7	856,9	839,8	823,4	807,4	791,9
	776,8	762,0	747,5	733,1	718,9	704,9	691,1	677,4
	663,9	650,7	637,8	625,2	612,9	601,1	589,7	578,8
	568,4	558,4	548,9	539,8	531,1	522,8	514,7	506,9
	499,2	491,7	484,2	476,8	469,3	461,9	454,4	446,9
	439,4	432,0	424,7	417,4	410,3	403,4	396,8	390,4
	384,3	378,5	372,9	367,7	362,7	358,0	353,5	349,1
	344,8	340,6	336,5	332,3	328,1	323,8	319,4	315,0
	310,5	306,0	301,4	296,9	292,4	288,0	283,8	279,7
	275,7	272,0	268,5	265,2	262,1	259,1	256,4	253,7
	251,2	248,7	246,3	243,8	241,3	238,7	236,0	233,3
	230,4	227,5	224,5	221,5	218,5	215,4	212,5	209,6
	206,9	204,2	201,8	199,5	197,4	195,4	193,6	191,9
	190,3	186,8	187,3	185,8	184,3	182,8	181,1	179,4
	177,5	175,6	173,5	171,5	169,4	167,2	165,1	162,9
	160,9	158,9	157,1	155,4	153,8	152,3	151,0	149,8
	148,7	147,7	146,8	145,8	144,9	143,9	142,9	141,8
	140,6	139,4	138,0	136,6	135,1	133,5	131,9	130,3
	128,7	127,2	125,8	124,4	123,2	122,0	121,0	120,1
	119,3	118,6	117,3	116,1	114,8	113,2	111,2	108,9
	106,5	104,0	101,5	99,8	98,3	97,1	96,3	95,5
	94,7	93,7	92,4	90,7	88,8	86,8	84,9	83,2
	81,8	80,8	80,1	79,7	79,2	78,7	77,9	76,7
	75,3	73,7	72,1	70,5	69,3	68,4	67,7	67,4
	67,1	66,8	66,3	65,6	64,5	63,3	61,9	60,6
	59,5	58,6	58,1	57,8	57,6	57,5	57,2	56,7
	55,9	54,9	53,8	52,6	51,6	50,7	50,2	49,9
	49,8	49,8	49,8	49,5	49,1	48,3	47,4	46,3
	45,3	44,4	43,8	43,5	43,4	42,7	38,8	38,3
	35,9	33,9	33,6	30,4	30,6	28,7	27,0	27,1
	24,7	24,9	23,3	22,2	22,5	20,2	20,6	19,5
	18,4	15,6	13,4	11,5	10,1	8,8	7,9	7,0
52	5,1	4,0	3,1	2,4	2,1	1,7	1,4	1,3
53	1,0	0,8	0,8	0,7	0,5	0,6	0,5	0,3
54	0,4	0,4	0,2	0,3	0,3	0,2	0,2	0,2
55	0,1	0,1	0,0	0,0	0,0	0,0	0,0	0,0
56	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
57	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
58	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
59	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
60	0,0	0,0	0,0	0,0				

F15

10 Hz B-W

-0.1	-0.4	-0.4	-0.3	-0.4	-0.5	-0.4	-0.[illegible]
-0.6	-0.5	-0.6	-0.7	-0.7	-0.7	-0.9	-0.9
-0.9	-1.2	-1.2	-1.3	-1.6	-1.8	-2.1	-2.6
-3.1	-3.8	-4.9	-6.5	-7.1	-8.1	-8.9	-10.2
-11.6	-13.4	-15.6	-16.5	-16.0	-17.9	-17.4	-18.3
-19.6	-19.0	-21.1	-20.8	-22.0	-23.4	-22.9	-25.5
-25.2	-26.6	-28.5	-28.2	-31.2	-31.2	-33.1	-34.0
-34.7	-35.2	-35.5	-35.5	-35.3	-35.1	-34.9	-35.0
-35.3	-35.9	-36.7	-37.6	-38.5	-39.3	-39.8	-40.0
-40.0	-39.8	-39.6	-39.6	-39.8	-40.3	-41.1	-42.0
-43.0	-44.0	-44.7	-45.1	-45.3	-45.2	-45.1	-45.1
-45.3	-45.7	-46.5	-47.5	-48.6	-49.7	-50.7	-51.3
-51.7	-51.8	-51.7	-51.6	-51.8	-52.2	-52.9	-54.0
-55.3	-56.6	-57.9	-58.9	-59.5	-59.8	-59.9	-59.8
-59.9	-60.2	-60.9	-62.0	-63.4	-64.9	-66.5	-67.8
-68.8	-69.5	-69.8	-70.0	-70.1	-70.5	-71.1	-72.2
-73.7	-75.4	-76.3	-77.2	-78.1	-78.9	-79.7	-80.3
-80.9	-81.4	-81.7	-82.0	-82.2	-82.4	-82.6	-82.7
-82.9	-83.1	-83.5	-83.9	-84.4	-85.0	-85.8	-86.7
-87.6	-88.7	-89.7	-90.8	-91.9	-93.0	-94.0	-94.9
-95.7	-96.4	-97.0	-97.5	-97.9	-98.2	-98.5	-98.7
-99.0	-99.3	-99.6	-100.1	-100.6	-101.3	-102.1	-103.1
-104.2	-105.4	-106.7	-108.0	-109.3	-110.7	-112.0	-113.3
-114.4	-115.5	-116.4	-117.2	-117.9	-118.5	-119.0	-119.4
-119.8	-120.2	-120.6	-121.2	-121.8	-122.5	-123.4	-124.5
-125.7	-127.0	-128.5	-130.1	-131.7	-133.4	-135.0	-136.7
-138.2	-139.7	-141.0	-142.2	-143.2	-144.1	-144.9	-145.6
-146.3	-146.9	-147.5	-148.2	-148.9	-149.8	-150.8	-152.0
-153.4	-154.9	-156.6	-158.5	-160.4	-162.4	-164.5	-166.5
-168.5	-170.4	-172.2	-173.8	-175.3	-176.5	-177.7	-178.7
-179.6	-180.4	-181.1	-181.9	-182.8	-183.7	-184.8	-186.1
-187.5	-189.2	-191.0	-193.0	-195.2	-197.5	-199.9	-202.3
-204.7	-207.0	-209.1	-211.1	-212.8	-214.4	-215.7	-216.8
-217.7	-218.4	-219.0	-219.6	-220.1	-220.7	-221.3	-222.1
-223.1	-224.3	-225.6	-227.2	-228.9	-230.7	-232.6	-234.6
-235.5	-236.4	-237.3	-238.2	-238.9	-239.7	-240.4	-241.0
-241.5	-241.9	-242.2	-242.5	-242.6	-242.7	-242.6	-242.4
-242.2	-241.8	-241.4	-240.8	-240.2	-239.4	-238.6	-237.8
-236.8	-235.9	-234.8	-233.7	-232.6	-231.5	-230.3	-229.2
-228.0	-226.8	-225.6	-224.4	-223.2	-221.9	-220.7	-219.5
-218.2	-217.0	-215.7	-214.3	-212.9	-211.5	-209.9	-208.3
-206.6	-204.7	-202.8	-200.6	-198.4	-195.9	-193.2	-190.3
-187.2	-183.9	-180.3	-176.4	-172.3	-167.9	-163.1	-158.1
-152.7	-147.0	-141.0	-134.7	-128.0	-121.0	-113.7	-106.0
-98.0	-89.7	-81.0	-72.0	-62.6	-52.9	-42.9	-32.5
-21.8	-10.7	0.8	12.6	24.8	37.4	50.4	63.8
77.7	92.1	106.9	122.3	138.3	154.8	172.0	189.9
208.5	227.8	247.9	268.9	290.8	313.6	337.5	362.4
388.4	415.5	443.9	473.5	504.4	536.7	570.4	605.6
642.3	680.6	720.5	762.0	805.3	850.3	897.2	945.9
996.5	1049.1	1103.7	1160.3	1219.0	1280.0	1343.1	1408.5
1476.2	1546.4	1619.0	1694.1	1771.8	1852.3	1935.5	2021.5
2110.5	2202.5	2297.6	2395.9	2497.5	2602.5	2711.0	2823.2
2939.0	3058.7	3182.2	3309.7	3441.4	3577.1	3717.2	3861.5
4010.2	4163.3	4320.9	4483.0	4649.5	4820.6	4996.1	5176.0
5360.2	5548.7	5741.4	5938.1	6138.7	6343.0	6550.8	6761.8
6976.0	7192.9	7412.2	7633.7	7857.1	8081.8	8307.7	8534.1
8760.9	8987.3	9213.2	9437.8	9660.9	9881.8	10100.1	10315.2
10526.8	10734.2	10936.9	11134.5	11326.5	11512.4	11691.7	11863.9
12028.7	12185.7	12334.3	12474.3	12605.4	12727.2	12839.4	12941.8
13034.2	13116.4	13188.3	13249.7	13300.6	13340.9	13370.7	13389.9
13398.7	13397.2	13385.4	13363.5	13331.9	13290.6	13239.9	13180.2
13111.7	13034.8	12949.8	12857.1				

F16 10 Hz BW

12757.0	12650.0	12536.5	12416.8	12291.5	12160.9	12025.4	11885.
11741.5	11594.0	11443.3	11289.8	11133.8	10975.9	10816.2	10655.3
10493.3	10330.7	10167.7	10004.6	9841.7	9679.2	9517.3	9356.3
9196.3	9037.5	8880.1	8724.1	8569.8	8417.3	8266.5	8117.7
7970.8	7826.0	7683.2	7542.6	7404.1	7267.7	7133.5	7001.4
6871.5	6743.8	6618.2	6494.8	6373.4	6254.2	6137.1	6022.1
5909.1	5798.2	5689.3	5582.4	5477.5	5374.6	5273.6	5174.6
5077.5	4982.4	4889.1	4797.7	4708.3	4620.6	4534.9	4450.9
4368.8	4288.5	4209.9	4133.2	4058.1	3984.8	3913.2	3843.2
3774.9	3708.1	3643.0	3579.3	3517.2	3456.5	3397.3	3339.4
3282.9	3227.6	3173.7	3120.9	3069.3	3018.9	2969.5	2921.2
2874.0	2827.7	2782.3	2737.8	2694.2	2651.5	2609.6	2568.4
2528.0	2488.4	2449.5	2411.2	2373.7	2336.8	2300.6	2265.0
2230.1	2195.8	2162.2	2129.1	2096.7	2064.9	2033.7	2003.2
1973.2	1943.8	1915.1	1886.9	1859.3	1832.4	1806.0	1780.2
1754.9	1730.3	1706.1	1682.5	1659.5	1636.9	1614.9	1593.4
1572.3	1551.6	1531.4	1511.7	1492.3	1473.3	1454.7	1436.4
1418.4	1400.8	1383.4	1366.3	1349.5	1333.0	1316.6	1300.5
1284.6	1268.9	1253.5	1238.2	1223.1	1208.1	1193.4	1178.8
1164.4	1150.2	1136.2	1122.4	1108.7	1095.3	1082.0	1068.9
1056.1	1043.5	1031.0	1018.8	1006.8	995.1	983.6	972.3
961.2	950.4	939.8	929.4	919.2	909.3	899.6	890.1
880.8	871.7	862.8	854.1	845.1	820.7	804.9	789.5
774.4	759.6	745.1	730.8	716.7	702.7	688.8	675.2
661.8	648.6	635.7	623.1	611.0	599.2	587.9	577.1
566.7	556.8	547.4	538.4	529.7	521.4	513.4	505.6
498.0	490.5	483.0	475.5	468.1	460.7	453.2	445.7
438.2	430.8	423.5	416.3	409.2	402.3	395.7	389.4
383.3	377.5	372.1	366.9	361.9	357.3	352.7	348.4
344.1	340.0	335.8	331.6	327.4	323.1	318.7	314.3
309.8	305.3	300.7	296.2	291.7	287.3	283.1	279.0
275.1	271.4	267.9	264.6	261.6	258.7	255.9	253.3
250.8	248.3	245.9	243.4	240.9	238.3	235.6	232.8
230.0	227.0	224.0	221.0	218.0	215.0	212.0	209.2
206.4	203.8	201.4	199.1	197.1	195.1	193.3	191.7
190.1	188.6	187.1	185.6	184.1	182.5	180.8	179.1
177.2	175.3	173.3	171.2	169.0	166.9	164.7	162.6
160.6	158.6	156.8	155.1	153.5	152.1	150.8	149.6
148.6	147.6	146.6	145.7	144.8	143.8	142.8	141.6
140.5	139.2	137.8	136.3	134.8	133.2	131.6	130.0
128.5	127.0	125.5	124.2	123.0	121.9	120.9	120.0
119.2	118.5	117.2	116.0	114.7	113.0	111.0	108.7
106.3	103.8	101.6	99.7	98.2	97.1	96.2	95.5
94.7	93.6	92.3	90.6	88.7	86.6	84.7	83.0
81.7	80.7	80.1	79.6	79.2	78.6	77.8	76.6
75.2	73.6	71.9	70.4	69.2	68.3	67.7	67.3
67.1	66.8	66.3	65.5	64.4	63.2	61.8	60.5
59.4	58.6	58.0	57.7	57.6	57.4	57.2	56.7
55.9	54.9	53.7	52.5	51.5	50.7	50.1	49.9
49.8	49.8	49.8	49.5	49.0	48.2	47.3	46.2
45.2	44.4	43.8	43.5	43.4	42.6	38.7	38.3
35.8	33.9	33.6	30.4	30.6	28.7	27.0	27.1
24.6	24.9	23.3	22.2	22.4	20.2	20.6	19.5
18.4	15.6	13.4	11.5	10.1	8.8	7.9	7.0
5.1	4.0	3.1	2.4	2.1	1.7	1.4	1.3
1.0	0.8	0.8	0.7	0.5	0.6	0.5	0.4
0.4	0.4	0.2	0.3	0.3	0.2	0.2	0.2
0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0				

F19

20Hz B-W

	-0.1	-0.4	-0.4	-0.3	-0.4	-0.5	-0.4	-0.5
	-0.6	-0.5	-0.5	-0.7	-0.7	-0.7	-0.9	-0.9
	-0.9	-1.2	-1.2	-1.3	-1.6	-1.8	-2.1	-2.6
1	-3.1	-3.8	-4.9	-6.5	-7.1	-8.1	-9.0	-10.3
2	-11.6	-13.4	-15.5	-16.5	-16.0	-18.0	-17.4	-18.3
3	-18.6	-19.0	-21.1	-20.8	-22.0	-23.4	-22.9	-25.6
4	-25.2	-26.6	-28.5	-28.2	-31.2	-31.2	-33.2	-34.0
5	-34.7	-35.2	-35.5	-35.5	-35.3	-35.1	-34.9	-35.0
6	-35.3	-35.9	-35.7	-37.7	-38.6	-39.3	-39.8	-40.0
7	-40.0	-39.8	-39.6	-39.6	-39.8	-40.3	-41.1	-42.1
8	-43.1	-44.0	-44.7	-45.1	-45.3	-45.2	-45.1	-45.1
9	-45.3	-45.8	-46.5	-47.5	-48.7	-49.8	-50.7	-51.3
10	-51.7	-51.7	-51.7	-51.6	-51.8	-52.2	-53.0	-54.1
11	-55.4	-56.7	-57.9	-58.9	-59.5	-59.8	-59.9	-59.8
12	-59.9	-60.3	-61.0	-62.1	-63.4	-65.0	-66.5	-67.9
13	-68.9	-69.5	-69.8	-70.0	-70.1	-70.5	-71.2	-72.3
14	-73.7	-75.5	-76.4	-77.3	-78.2	-79.0	-79.7	-80.4
15	-80.9	-81.4	-81.8	-82.0	-82.2	-82.4	-82.6	-82.7
16	-82.9	-83.2	-83.5	-83.9	-84.4	-85.1	-85.9	-86.7
17	-87.7	-88.7	-89.8	-90.9	-92.0	-93.1	-94.1	-95.0
18	-95.8	-96.5	-97.1	-97.6	-97.9	-98.3	-98.5	-98.8
19	-99.0	-99.3	-99.7	-100.1	-100.7	-101.4	-102.2	-103.2
20	-104.3	-105.5	-106.8	-108.1	-109.5	-110.8	-112.1	-113.4
21	-114.5	-115.6	-116.5	-117.3	-118.0	-118.5	-119.0	-119.4
22	-119.8	-120.2	-120.7	-121.2	-121.8	-122.6	-123.5	-124.6
23	-125.8	-127.1	-128.5	-130.2	-131.8	-133.5	-135.2	-136.8
24	-138.3	-139.8	-141.1	-142.3	-143.3	-144.2	-145.0	-145.7
25	-146.3	-146.9	-147.5	-148.2	-149.0	-149.9	-150.9	-152.1
26	-153.5	-155.0	-156.8	-158.6	-160.6	-162.6	-164.6	-166.7
27	-168.7	-170.5	-172.3	-173.9	-175.4	-176.6	-177.8	-178.7
28	-179.6	-180.4	-181.2	-182.0	-182.8	-183.8	-184.9	-186.2
29	-187.6	-189.3	-191.2	-193.2	-195.4	-197.7	-200.1	-202.5
30	-204.9	-207.1	-209.3	-211.2	-213.0	-214.5	-215.8	-216.9
31	-217.7	-218.5	-219.1	-219.6	-220.2	-220.7	-221.4	-222.2
32	-223.2	-224.4	-225.7	-227.3	-229.0	-230.9	-232.8	-234.7
33	-235.6	-236.6	-237.4	-238.3	-239.1	-239.8	-240.5	-241.0
34	-241.5	-242.0	-242.3	-242.5	-242.6	-242.7	-242.6	-242.4
35	-242.1	-241.7	-241.3	-240.7	-240.1	-239.3	-238.5	-237.6
36	-236.7	-235.7	-234.7	-233.6	-232.5	-231.3	-230.2	-229.0
37	-227.8	-226.6	-225.4	-224.2	-223.0	-221.7	-220.5	-219.3
38	-218.0	-216.8	-215.4	-214.1	-212.7	-211.2	-209.7	-208.0
39	-206.3	-204.4	-202.4	-200.3	-198.0	-195.5	-192.8	-189.9
40	-186.7	-183.4	-179.7	-175.8	-171.6	-167.1	-162.4	-157.3
41	-151.9	-146.1	-140.1	-133.7	-127.0	-119.9	-112.5	-104.8
42	-96.7	-88.3	-79.5	-70.5	-61.1	-51.4	-41.3	-30.8
43	-20.0	-8.9	2.5	14.5	26.7	39.4	52.4	65.9
44	79.9	94.3	109.3	124.8	140.8	157.5	174.8	192.7
45	211.4	230.9	251.1	272.3	294.3	317.3	341.3	366.4
46	392.5	419.9	448.4	478.2	509.4	541.9	575.8	611.2
47	648.2	686.7	726.8	768.7	812.2	857.5	904.7	953.7
48	1004.6	1057.5	1112.4	1169.3	1228.4	1289.7	1353.1	1418.9
49	1487.0	1557.5	1630.5	1706.1	1784.2	1865.1	1948.7	2035.2
50	2124.6	2217.1	2312.7	2411.5	2513.7	2619.2	2728.3	2841.0
51	2957.4	3077.7	3201.9	3330.0	3462.3	3598.7	3739.4	3884.5
52	4033.9	4187.7	4345.0	4508.7	4676.0	4847.7	5023.9	5204.5
53	5389.4	5578.6	5771.9	5969.2	6170.4	6375.3	6583.6	6795.2
54	7009.8	7227.1	7446.9	7668.7	7892.3	8117.3	8343.2	8569.8
55	8796.5	9022.9	9248.6	9473.1	9695.8	9916.4	10134.2	10348.9
56	10559.8	10766.5	10968.5	11165.3	11356.3	11541.2	11719.4	11890.6
57	12054.2	12209.8	12357.1	12495.8	12625.4	12745.7	12856.4	12957.3
58	13048.1	13128.7	13198.9	13258.7	13307.9	13346.6	13374.7	13392.2
59	13399.4	13396.2	13382.8	13359.4	13326.2	13283.4	13231.3	13170.1
60	13100.3	13022.0	12935.8	12841.9				

F20

20 Hz B-W

	12740,7	12532,6	12518,1	12397,5	12271,3	12139,8	12003,6	11863,0
	11718,5	11570,4	11419,2	11265,2	11109,0	10950,7	10790,8	10629,7
	10467,6	10304,9	10141,8	9978,7	9815,9	9653,4	9491,7	9330,8
	9171,0	9012,4	8855,2	8699,5	8545,5	8393,2	8242,7	8094,2
	7947,7	7803,1	7660,7	7520,4	7382,2	7246,2	7112,3	6980,6
	6851,0	6723,6	6598,4	6475,3	6354,3	6235,5	6118,7	6004,0
4	5891,3	5780,7	5672,1	5565,6	5461,0	5358,4	5257,7	5159,0
5	5062,2	4967,4	4874,4	4783,4	4694,2	4606,8	4521,4	4437,7
6	4355,9	4275,8	4197,6	4121,1	4046,3	3973,3	3901,9	3832,2
7	3764,1	3697,6	3632,7	3569,3	3507,4	3447,0	3387,9	3330,3
8	3274,0	3218,9	3165,2	3112,6	3061,2	3010,9	2961,8	2913,6
9	2866,5	2820,4	2775,1	2730,8	2687,4	2644,8	2603,0	2561,9
10	2521,7	2482,1	2443,3	2405,2	2367,8	2331,0	2294,9	2259,4
11	2224,6	2190,4	2156,9	2123,9	2091,6	2059,9	2028,8	1998,3
12	1968,5	1939,2	1910,5	1882,5	1855,0	1828,1	1801,8	1776,1
13	1751,0	1726,4	1702,3	1678,8	1655,9	1633,4	1611,4	1590,0
14	1568,9	1548,4	1528,3	1508,6	1489,2	1470,3	1451,7	1433,5
15	1416,6	1398,0	1380,7	1363,6	1346,9	1330,3	1314,0	1298,0
16	1282,1	1266,5	1251,0	1235,7	1220,7	1205,8	1191,0	1176,5
17	1162,2	1148,0	1134,0	1120,2	1106,6	1093,1	1079,9	1066,9
18	1054,1	1041,5	1029,1	1016,9	1005,0	993,2	981,7	970,5
19	959,5	948,7	938,1	927,8	917,6	907,7	898,1	888,6
20	879,3	870,3	861,4	852,7	835,8	819,4	803,6	788,2
21	773,2	758,5	744,0	729,7	715,5	701,6	687,8	674,1
22	660,7	647,5	634,7	622,2	610,0	598,3	587,0	576,2
23	565,9	556,1	546,7	537,7	529,1	520,8	512,8	505,0
24	497,4	489,9	482,4	475,0	467,5	460,1	452,6	445,1
25	437,6	430,2	422,9	415,7	408,6	401,8	395,2	388,9
26	382,8	377,1	371,6	366,5	361,6	356,9	352,4	348,0
27	343,8	339,6	335,4	331,3	327,0	322,7	318,4	313,9
28	309,4	304,9	300,3	295,8	291,4	287,0	282,8	278,7
29	274,8	271,1	267,6	264,4	261,3	258,4	255,7	253,1
30	250,6	248,1	245,7	243,2	240,7	238,1	235,4	232,6
31	229,7	226,8	223,8	220,8	217,7	214,7	211,8	208,9
32	206,2	203,6	201,2	199,0	196,9	195,0	193,2	191,5
33	190,0	188,5	187,0	185,5	184,0	182,4	180,7	179,0
34	177,1	175,1	173,1	171,0	168,9	166,7	164,5	162,4
35	160,4	158,5	156,6	155,0	153,4	152,0	150,7	149,5
36	148,5	147,5	146,5	145,6	144,7	143,7	142,7	141,6
37	140,4	139,1	137,7	136,2	134,7	133,1	131,5	129,9
38	128,4	126,9	125,4	124,1	122,9	121,8	120,8	119,9
39	119,1	118,4	117,2	116,0	114,6	112,9	110,9	108,7
40	106,2	103,8	101,5	99,6	98,1	97,0	96,2	95,4
41	94,6	93,6	92,2	90,5	88,6	86,6	84,6	83,0
42	81,6	80,7	80,1	79,6	79,2	78,6	77,7	76,6
43	75,1	73,5	71,9	70,4	69,2	68,3	67,7	67,3
44	67,1	66,7	65,2	65,4	64,4	63,1	61,8	60,5
45	59,4	58,5	58,0	57,7	57,6	57,4	57,1	56,6
46	55,8	54,8	53,6	52,5	51,4	50,6	50,1	49,9
47	49,8	49,8	49,7	49,5	49,0	48,2	47,2	46,2
48	45,2	44,4	43,8	43,4	43,4	42,6	38,7	38,3
49	36,8	33,9	33,6	30,4	30,6	28,6	27,0	27,1
50	24,6	24,9	23,3	22,2	22,4	20,2	20,6	19,5
51	18,4	15,6	13,4	11,5	10,2	8,8	7,9	7,0
52	5,1	4,0	3,1	2,4	2,1	1,7	1,4	1,3
53	1,0	0,8	0,8	0,7	0,5	0,6	0,5	0,4
54	0,4	0,4	0,2	0,3	0,3	0,2	0,2	0,2
55	0,1	0,1	0,0	0,0	0,0	0,0	0,0	0,0
56	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
57	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
58	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
59	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
60	0,0	0,0	0,0	0,0				

F23

50 Hz B-W

	-0,1	-0,4	-0,4	-0,3	-0,4	-0,5	-0,4	-0,5
	-0,6	-0,5	-0,6	-0,7	-0,7	-0,7	-0,9	-0,9
	-0,9	-1,2	-1,2	-1,3	-1,6	-1,8	-2,1	-2,6
1	-3,1	-3,8	-4,9	-6,5	-7,2	-8,1	-9,0	-10,3
2	-11,6	-13,4	-15,5	-16,5	-16,0	-18,0	-17,4	-18,3
3	-19,6	-19,0	-21,1	-20,8	-22,0	-23,3	-22,9	-25,6
4	-25,2	-26,6	-28,5	-28,2	-31,2	-31,2	-33,2	-34,0
5	-34,7	-35,2	-35,5	-35,5	-35,3	-35,1	-34,9	-35,0
6	-35,3	-35,9	-35,8	-37,7	-38,6	-39,3	-39,8	-40,0
7	-40,0	-39,8	-39,5	-39,6	-39,8	-40,4	-41,1	-42,1
8	-43,1	-44,0	-44,7	-45,1	-45,3	-45,2	-45,1	-45,1
9	-45,3	-45,8	-45,5	-47,6	-48,7	-49,8	-50,7	-51,3
10	-51,7	-51,7	-51,7	-51,6	-51,8	-52,2	-53,0	-54,1
11	-55,4	-56,7	-57,9	-58,9	-59,5	-59,8	-59,9	-59,8
12	-59,9	-60,3	-61,0	-62,1	-63,5	-65,0	-66,6	-67,9
13	-68,9	-69,5	-69,8	-70,0	-70,1	-70,5	-71,2	-72,3
14	-73,8	-75,5	-75,4	-77,3	-78,2	-79,0	-79,8	-80,4
15	-81,0	-81,4	-81,8	-82,0	-82,3	-82,4	-82,6	-82,7
16	-82,9	-83,2	-83,5	-83,9	-84,5	-85,1	-85,9	-86,8
17	-87,8	-88,8	-89,9	-91,0	-92,1	-93,1	-94,1	-95,0
18	-95,8	-96,5	-97,1	-97,6	-98,0	-98,3	-98,5	-98,8
19	-99,0	-99,3	-99,7	-100,1	-100,7	-101,4	-102,3	-103,2
20	-104,3	-105,5	-105,8	-108,2	-109,5	-110,9	-112,2	-113,4
21	-114,6	-115,6	-116,5	-117,3	-118,0	-118,5	-119,0	-119,4
22	-119,8	-120,2	-120,7	-121,2	-121,9	-122,6	-123,5	-124,6
23	-125,8	-127,2	-128,7	-130,3	-131,9	-133,6	-135,2	-136,9
24	-138,4	-139,8	-141,1	-142,3	-143,4	-144,3	-145,0	-145,7
25	-146,4	-147,0	-147,5	-148,3	-149,0	-149,9	-151,0	-152,2
26	-153,6	-155,1	-156,8	-158,7	-160,7	-162,7	-164,7	-166,8
27	-168,8	-170,6	-172,4	-174,0	-175,4	-176,7	-177,8	-178,8
28	-179,7	-180,5	-181,2	-182,0	-182,9	-183,8	-184,9	-186,2
29	-187,7	-189,4	-191,3	-193,3	-195,5	-197,8	-200,2	-202,6
30	-205,0	-207,2	-209,4	-211,3	-213,0	-214,6	-215,8	-216,9
31	-217,8	-218,5	-219,1	-219,6	-220,2	-220,8	-221,4	-222,3
32	-223,2	-224,4	-225,8	-227,4	-229,1	-231,0	-232,9	-234,8
33	-235,7	-236,6	-237,5	-238,4	-239,1	-239,9	-240,5	-241,1
34	-241,6	-242,0	-242,3	-242,5	-242,6	-242,7	-242,6	-242,4
35	-242,1	-241,7	-241,2	-240,7	-240,0	-239,2	-238,4	-237,5
36	-236,6	-235,6	-234,6	-233,5	-232,4	-231,2	-230,0	-228,9
37	-227,7	-226,5	-225,3	-224,1	-222,8	-221,6	-220,4	-219,2
38	-217,9	-216,6	-215,3	-214,0	-212,5	-211,1	-209,5	-207,9
39	-206,1	-204,3	-202,2	-200,1	-197,8	-195,2	-192,5	-189,6
40	-186,4	-183,0	-179,4	-175,4	-171,2	-166,7	-161,9	-156,8
41	-151,3	-145,6	-139,5	-133,1	-126,3	-119,2	-111,8	-104,0
42	-95,9	-87,5	-78,7	-69,6	-60,2	-50,4	-40,3	-29,8
43	-18,0	-7,8	3,7	15,6	27,9	40,6	53,7	67,3
44	81,3	95,7	110,7	126,3	142,4	159,1	176,4	194,5
45	213,2	232,8	253,1	274,3	296,5	319,5	343,6	368,8
46	395,1	422,5	451,2	481,1	512,4	545,0	579,1	614,7
47	651,8	690,4	730,7	772,7	816,4	861,9	909,2	958,4
48	1009,5	1062,6	1117,7	1174,9	1234,1	1295,6	1359,3	1425,3
49	1493,6	1564,4	1637,5	1713,4	1791,8	1872,9	1956,8	2043,6
50	2133,3	2226,1	2322,0	2421,1	2523,6	2629,5	2738,9	2852,0
51	2968,7	3089,4	3213,9	3342,5	3475,1	3612,0	3753,1	3898,5
52	4048,3	4202,6	4361,3	4524,5	4692,2	4864,3	5041,0	5222,0
53	5407,3	5596,9	5790,5	5988,3	6189,8	6395,0	6603,7	6815,6
54	7030,5	7248,0	7468,0	7690,0	7913,7	8138,8	8364,9	8591,5
55	8818,2	9044,6	9270,2	9494,5	9717,0	9937,4	10154,9	10369,3
56	10579,8	10786,1	10987,5	11183,9	11374,4	11558,6	11736,2	11906,6
57	12069,5	12224,4	12370,9	12508,7	12637,4	12756,8	12866,6	12966,5
58	13056,4	13136,0	13205,2	13263,9	13312,2	13349,8	13376,9	13393,5
59	13399,6	13395,4	13381,1	13356,7	13322,6	13278,9	13225,9	13163,9
60	13093,2	13014,2	12927,2	12832,6				

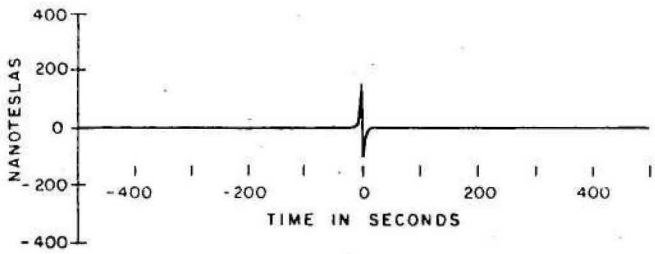
F24

50 Hz B-W

	12730,7	12522,0	12336,8	12385,7	12258,9	12127,0	11990,4	11849,4
	11704,5	11556,1	11404,6	11250,4	11093,9	10935,5	10775,5	10614,2
	10452,0	10289,3	10125,2	9963,1	9806,3	9637,9	9476,2	9315,4
1	9155,7	8997,2	8840,2	8684,6	8530,8	8379,7	8228,4	8080,1
2	7933,7	7789,4	7647,2	7507,0	7369,1	7233,2	7099,6	6968,1
3	6838,7	6711,5	6585,5	6463,6	6342,8	6224,2	6107,6	5993,1
4	5880,6	5770,2	5661,5	5555,4	5451,0	5348,6	5248,2	5149,6
5	5053,0	4958,4	4865,6	4774,7	4685,7	4598,6	4513,3	4429,8
6	4348,1	4268,3	4190,2	4113,8	4039,2	3966,3	3895,1	3825,6
7	3757,7	3691,3	3626,5	3563,3	3501,5	3441,2	3382,3	3324,8
8	3268,6	3213,7	3160,1	3107,6	3056,3	3006,2	2957,1	2909,1
9	2862,0	2816,0	2770,9	2726,6	2683,2	2640,7	2599,0	2558,0
10	2517,8	2478,4	2439,6	2401,6	2364,2	2327,5	2291,5	2256,1
11	2221,3	2187,2	2153,7	2120,8	2088,5	2056,9	2025,9	1995,4
12	1965,6	1936,4	1907,8	1879,8	1852,4	1825,6	1799,3	1773,7
13	1748,6	1724,0	1700,0	1676,6	1653,7	1631,3	1609,4	1587,9
14	1567,0	1546,4	1526,4	1506,7	1487,4	1468,5	1450,0	1431,8
15	1413,9	1396,3	1379,0	1362,0	1345,3	1328,8	1312,5	1296,4
16	1280,6	1265,0	1249,5	1234,3	1219,2	1204,3	1189,6	1175,1
17	1160,8	1146,6	1132,5	1118,9	1105,3	1091,9	1078,6	1065,6
18	1052,8	1040,3	1027,9	1015,7	1003,8	992,1	980,7	969,4
19	958,4	947,6	937,1	926,8	916,7	906,8	897,2	887,7
20	878,5	869,4	860,5	851,8	843,0	818,7	802,9	787,5
21	772,5	757,8	743,3	729,0	714,9	700,9	687,1	673,5
22	660,1	646,9	634,1	621,6	609,4	597,7	586,5	575,7
23	565,4	555,6	546,2	537,2	528,7	520,4	512,4	504,6
24	497,0	489,5	482,0	474,6	467,2	459,7	452,2	444,7
25	437,3	429,9	422,5	415,3	408,3	401,5	394,9	388,6
26	382,5	376,8	371,4	366,2	361,3	356,7	352,2	347,8
27	343,6	339,4	335,2	331,1	326,8	322,5	318,2	313,7
28	309,2	304,7	300,1	295,6	291,1	286,8	282,6	278,5
29	274,6	270,9	267,5	264,2	261,2	258,3	255,6	253,0
30	250,5	248,0	245,6	243,1	240,6	237,9	235,3	232,5
31	229,6	226,7	223,5	220,6	217,6	214,6	211,6	208,8
32	206,1	203,5	201,1	198,9	196,8	194,9	193,1	191,5
33	189,9	188,4	186,9	185,4	183,9	182,3	180,6	178,9
34	177,0	175,0	173,0	170,9	168,8	166,6	164,4	162,3
35	160,3	158,4	156,5	154,9	153,3	151,9	150,7	149,5
36	148,4	147,4	146,5	145,6	144,6	143,7	142,6	141,5
37	140,3	139,0	137,6	136,1	134,6	133,0	131,4	129,8
38	128,3	126,8	125,4	124,0	122,8	121,7	120,7	119,9
39	119,1	118,4	117,2	115,9	114,6	112,9	110,9	108,6
40	106,1	103,7	101,5	99,6	98,1	97,0	96,2	95,4
41	94,6	93,8	92,9	90,5	88,5	86,5	84,6	82,9
42	81,6	80,7	80,1	79,6	79,2	78,6	77,7	76,5
43	75,1	73,5	71,9	70,3	69,1	68,2	67,7	67,3
44	67,1	66,7	66,2	65,4	64,4	63,1	61,7	60,4
45	59,3	58,5	58,0	57,7	57,6	57,4	57,1	56,6
46	55,8	54,8	53,6	52,5	51,4	50,6	50,1	49,9
47	49,8	49,8	49,7	49,5	49,0	48,2	47,2	46,2
48	45,2	44,3	43,8	43,4	43,4	42,6	38,7	38,3
49	35,8	33,9	33,5	30,4	30,6	28,6	27,0	27,1
50	24,6	24,9	23,3	22,2	22,4	20,2	20,6	19,5
51	18,4	15,6	13,4	11,5	10,2	8,8	7,9	7,0
52	5,1	4,0	3,1	2,4	2,1	1,7	1,4	1,3
53	1,0	0,8	0,8	0,7	0,5	0,6	0,5	0,4
54	0,4	0,4	0,2	0,3	0,3	0,2	0,2	0,2
55	0,1	0,1	0,0	0,0	0,0	0,0	0,0	0,0
56	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
57	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
58	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
59	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
60	0,0	0,0	0,0	0,0				

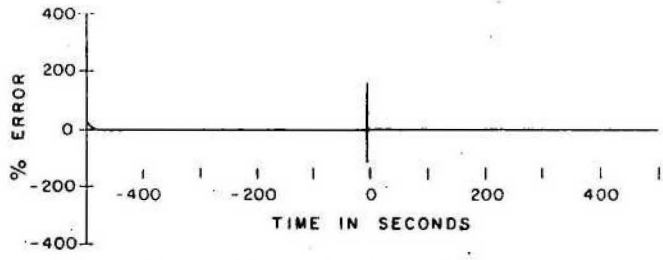
PRINTOUT FOR 100 Hz B/W DESTROYED

F 5, 6, 9, 10, 13, 14



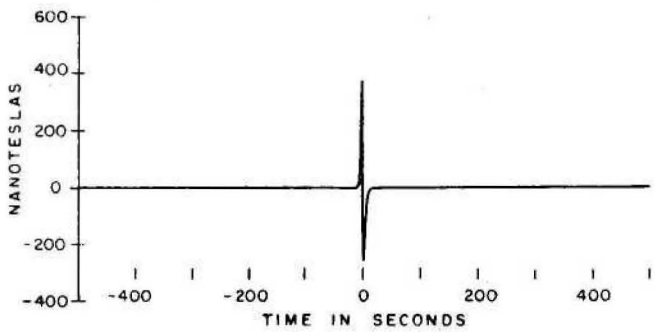
G 13 ERROR B-W

B-W = 5 Hz



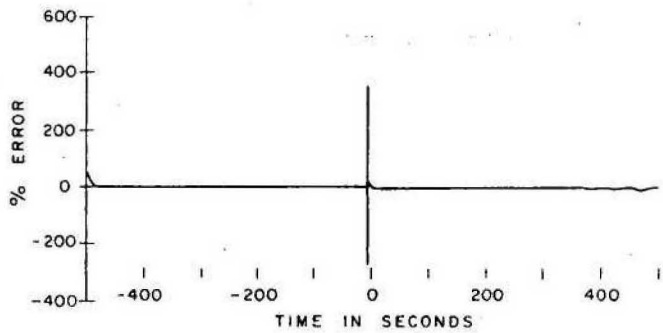
G 14 % ERROR B-W

B-W = 5 Hz



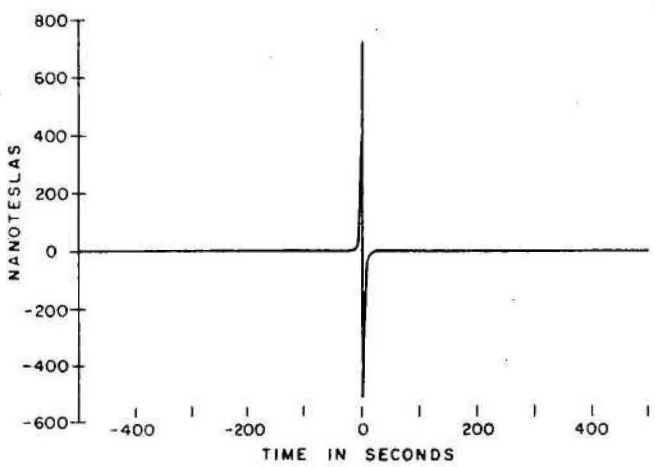
G 9 ERROR B-W

B-W = 2 Hz



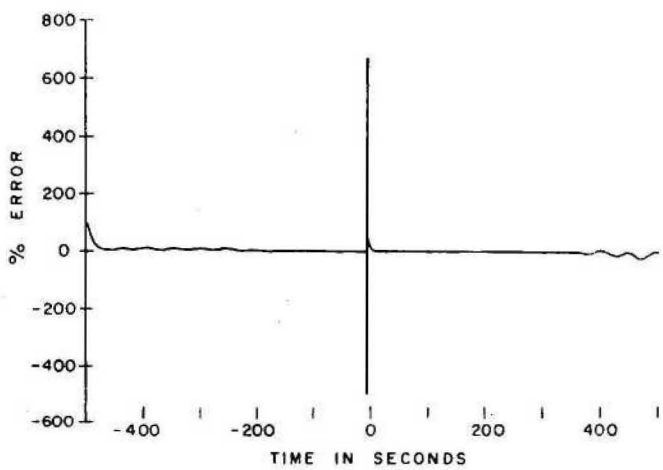
G 10 % ERROR B-W

B-W = 2Hz



G 5 ERROR B-W

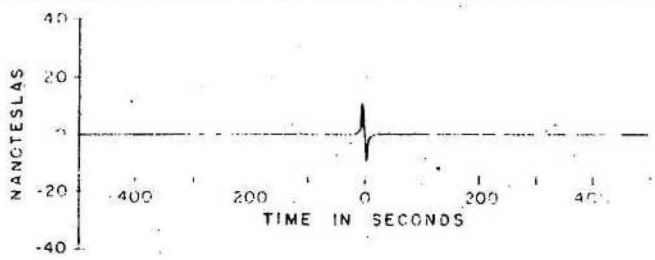
B-W = 1 Hz



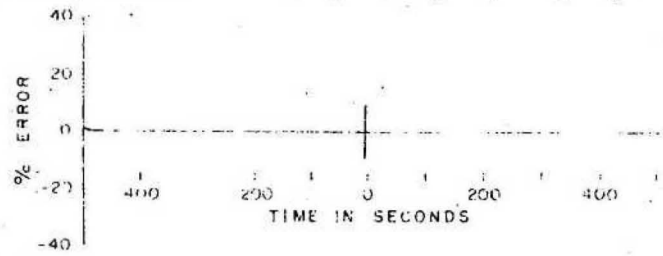
G 6 % ERROR B-W

B-W = 1 Hz

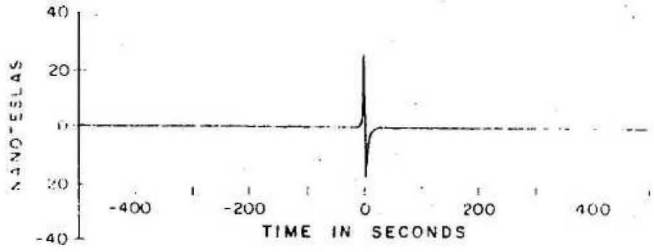
F 17, 18, 21, 22, 25, 26, 27, 28



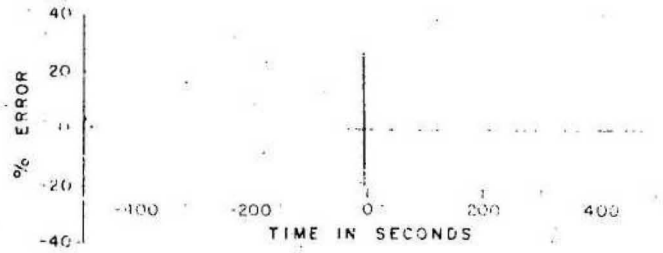
G 27 ERROR B-W
B-W = 100 Hz



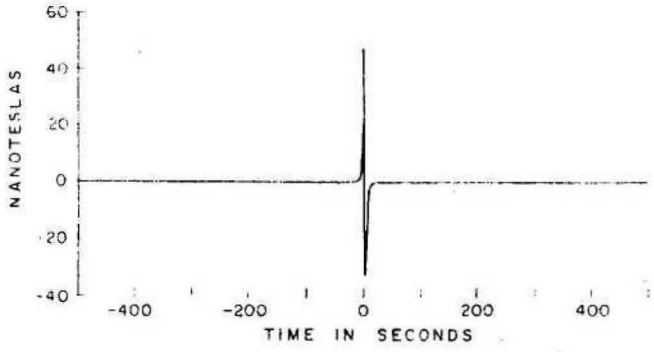
G 28 % ERROR B-W
B-W = 100 Hz



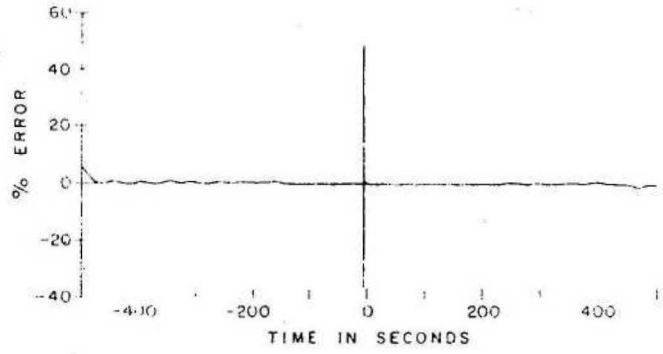
G 25 ERROR B-W
B-W = 50 Hz



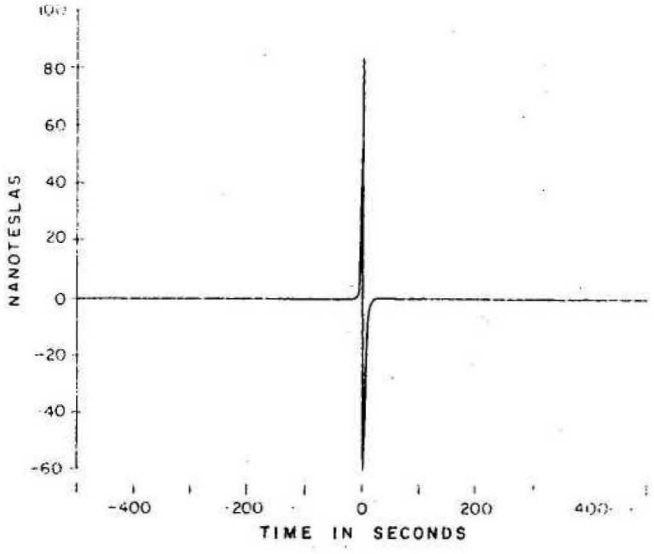
G 26 % ERROR B-W
B-W = 50 Hz



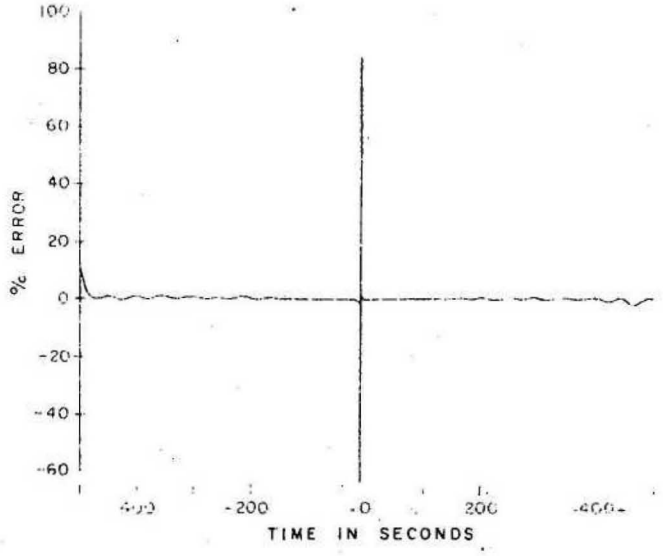
G 21 ERROR B-W
B-W = 20 Hz



G 22 % ERROR B-W
B-W = 20 Hz



G 17 ERROR B-W
B-W = 10 Hz



G 18 % ERROR B-W
B-W = 10 Hz

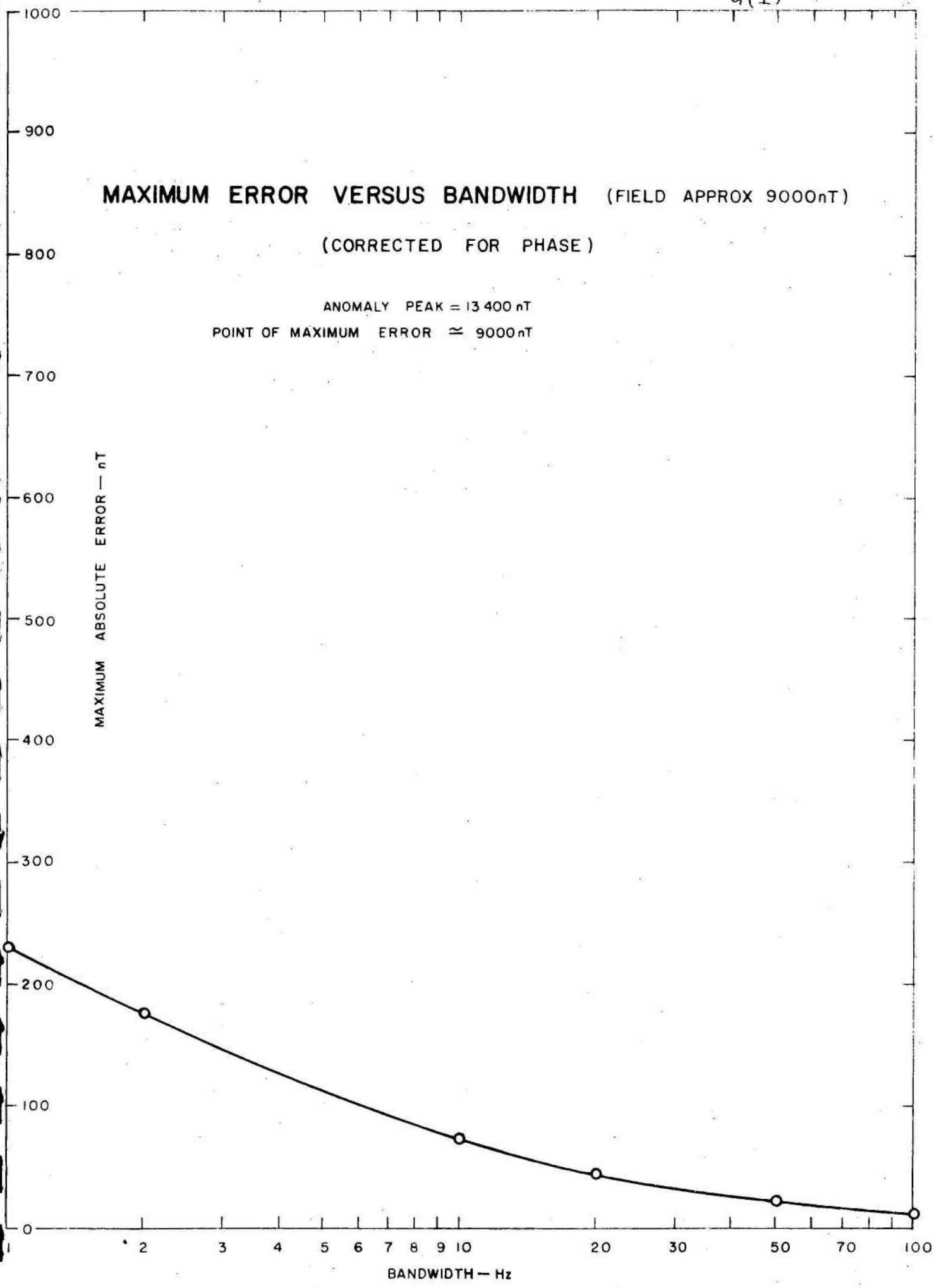
APPENDIX (G)

G(1) MAX ERROR - BANDWIDTH CURVE

G(2) ANOMALY PEAK ERROR - BANDWIDTH CURVE

G(3) PHASE ERROR - BANDWIDTH CURVE

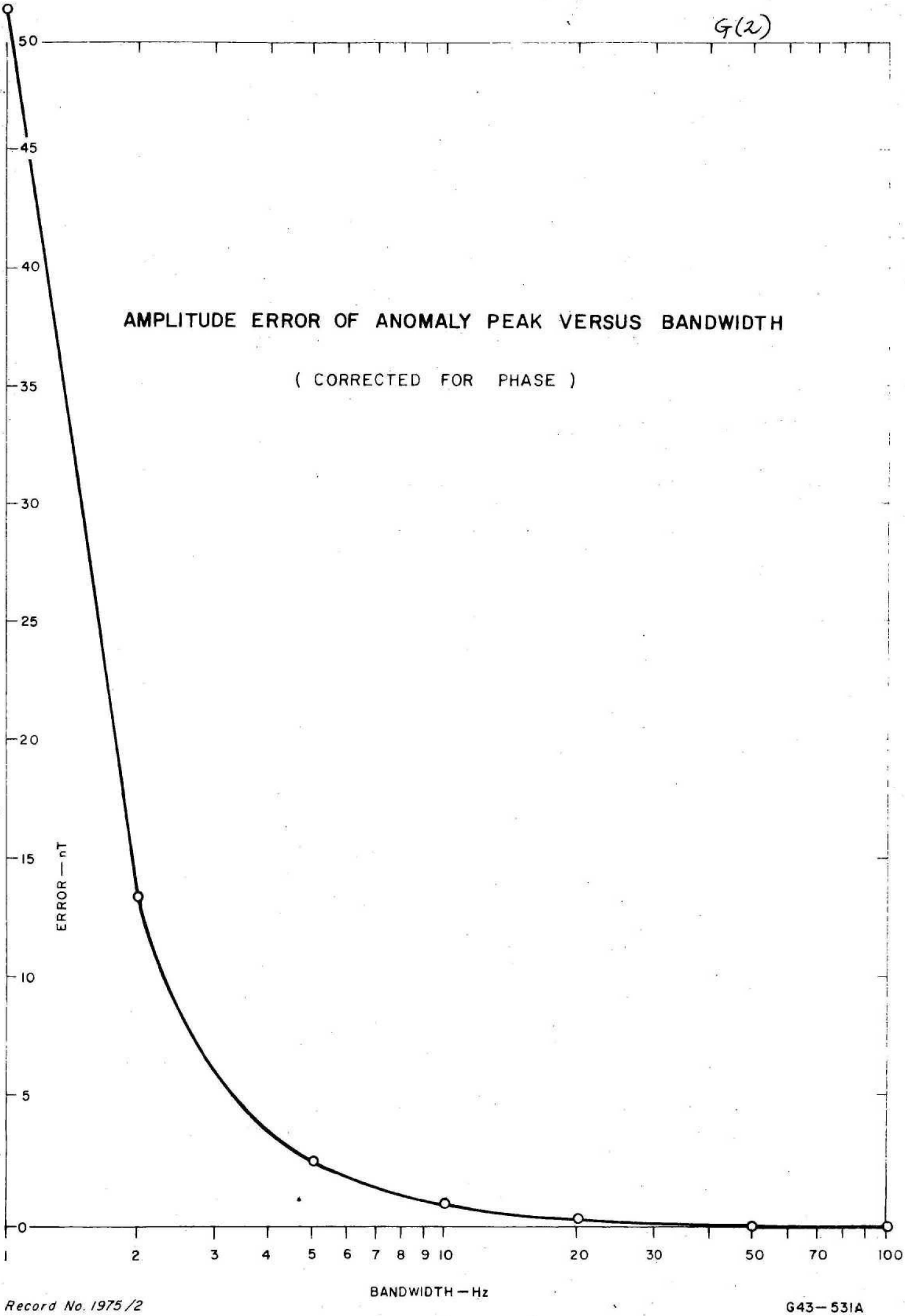
G(1)



Record No. 1975/2

G43 — 532A

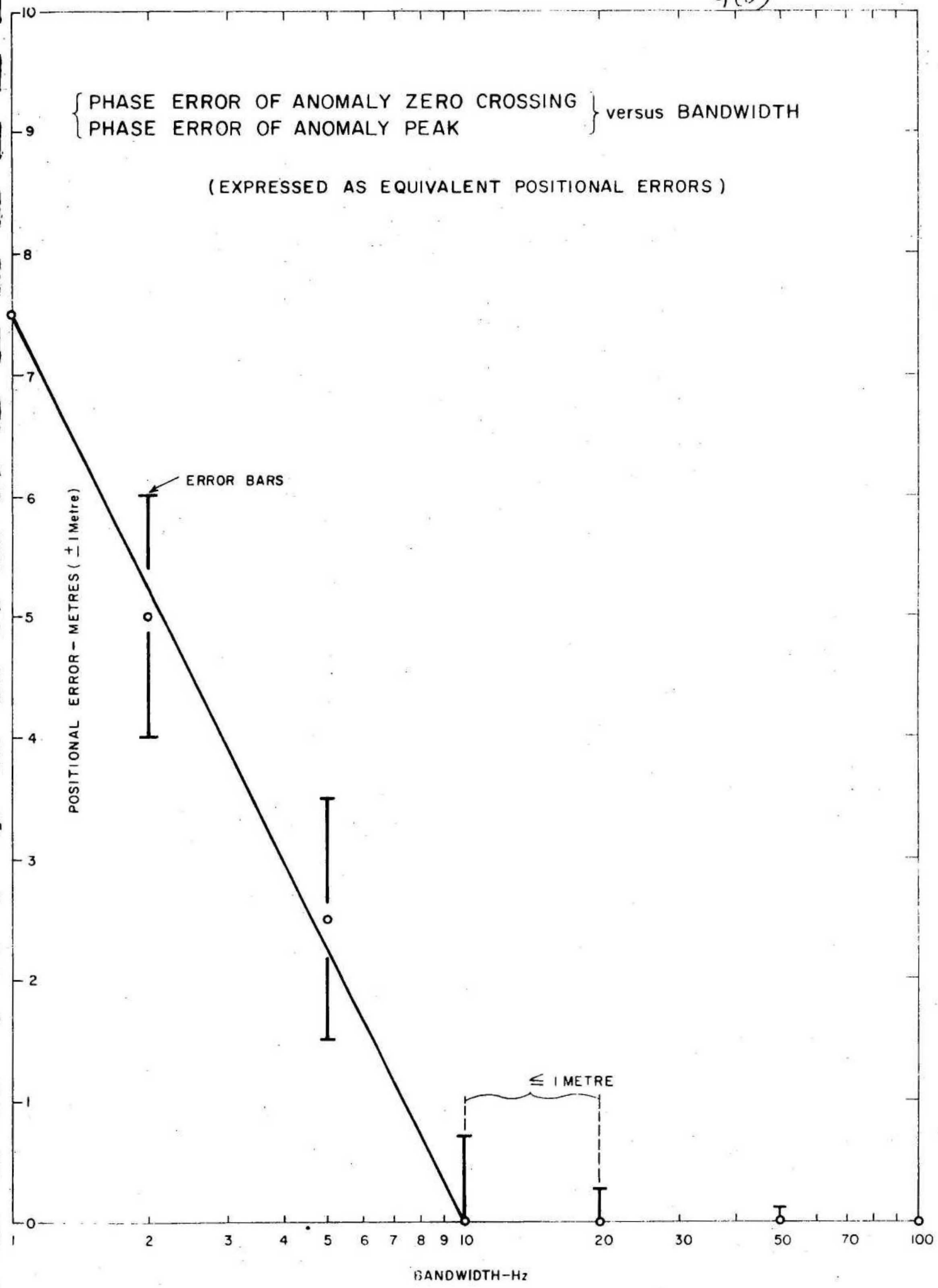
G(2)



Record No. 1975/2

G43—531A

4(3)



Record. No. 1975/2

G43-530A