GURALP SYSTEMS

TEST AND CALIBRATION DATA

CMG-40T-OBS

Serial No. T4P98

DESIGNED AND MANUFACTURED BY:

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1. CALIBRATION SHEET

* The data provided in the calibration sheet are the measured velocity responsivities over the flat portion of the sensor frequency response. The velocity responses are given in units of Volts/metre/second (V/m/s).

The sensor velocity outputs are differential (push-pull or balanced output) and it is required that a factor of * 2 must be used when the sensor outputs are interfaced to a recording system with a differential input. For example, in the calibration sheet, the velocity responsivity may be given as 2 * 1000 V/m/s which includes the factor * 2.

CAUTION

Do not ground any of the differential outputs. When interfaced to a single input recording system use the signal ground as the return line.

* The mass position output (also known as the acceleration output) is given in units of $V/m/s^2$. This is a single ended output referenced to the signal ground.

* The feedback coil constant given in $Ampere/metre/second^2$ ($A/m/s^2$) is an important parameter used when calibrating the sensor by injecting calibration signals into the sensor.

* Works Order Number is the number used at Güralp Systems Limited to file sensor manufacturing details.

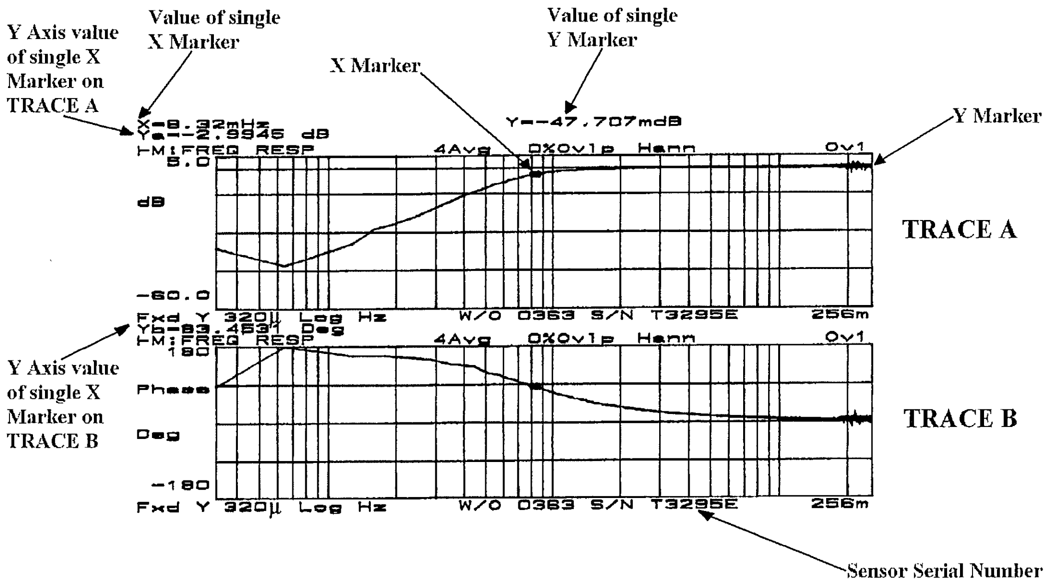
2. FREQUENCY RESPONSE

The frequency response of each component is provided as amplitude and phase plots.

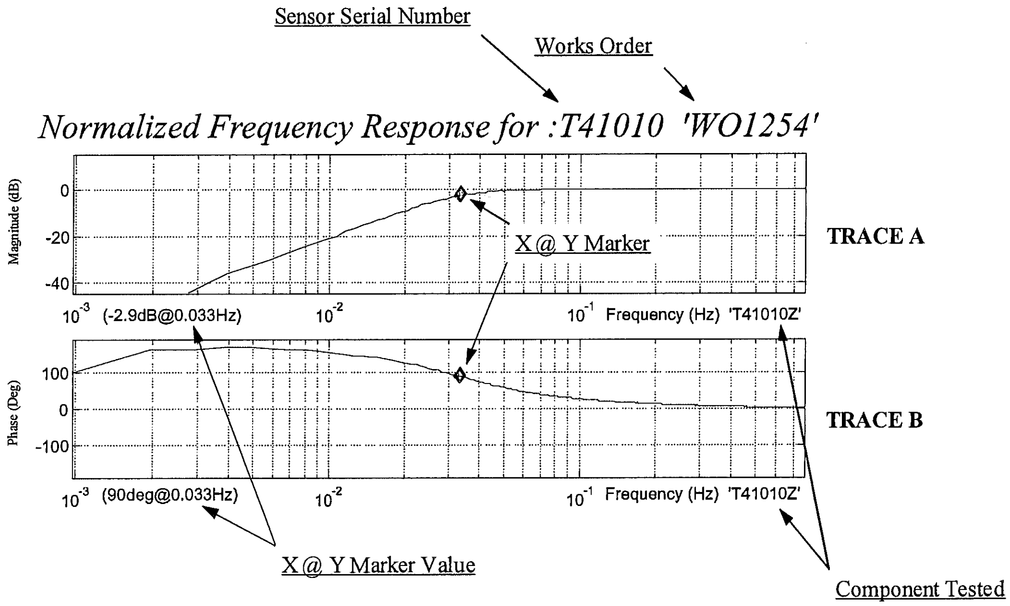
When testing the instrument, to confirm that it meets its design specification, it is most convenient in any one test to concentrate the range of frequencies over about 3 decades (i.e. 1000:1) of excitation frequencies, in the low and high end of the spectrum separately. Consequently the normalized frequency plots of each component are provided as low frequency and high frequency sections. In each plot, the low frequency cut-off value and the high frequency cut-off values (often quoted as -3dB or half power points) are marked. The frequency responses are normalized (unity gain) in order to show the corner frequencies.

Frequency response tests are always performed on every sensor produced at Güralp Systems Limited and records are archived for future reference.

There are two types of frequency plot representations. These are explained in the following frequency amplitude and phase plots.



Frequency response from 320μHz to 256 milliHz
TRACE A:- Y axis in dB.
TRACE B:- Y axis in degrees.



Normalized Frequency Response from 976.5 µHz to 781.25 mHz
TRACE A:- Y axis in dB
TRACE B:- Y axis in degrees.

3. SENSOR TRANSFER FUNCTION

It is convenient for most users of seismometers to consider the sensors as 'black-boxes'. Thus the details of the internal mechanics and electronics need not be known, but only the overall effect of the instrument in producing a usable output signal V from the desired input variable of x is required. The generic form of such a transfer function (in terms of Laplace variable s) is given as:

$$\frac{V}{x}(s) = G * A * H(s)$$

where:

G : is the velocity output sensitivity (gain constant) of the instrument relating to the actual output to the desired input over the flat portion of the frequency response. Output sensitivity is supplied in the calibration sheet. As well as the output sensitivity, a frequency response plot for each component incorporating the sensor gain is also shown. A straight line is drawn showing the sensor sensitivity value over a wide frequency range.

H(s) : the transfer function of the sensor can be expressed in factored form.

$$H(s) = \frac{\prod_{n=1}^{N} (s-z_n)}{\prod_{m=1}^{M} (s-p_m)}$$

—

z_n are the roots of the numerator polynomial, giving the zeros of the transfer function, and p_m are the roots of the denominator polynomial giving the poles of the transfer function. See: poles and zero table.

A : is a constant which is evaluated to make the magnitude of A * H(s) unity, with no dimensions over the flat portion of the frequency response. In practice it is possible to design a system transfer function with a very wide range of flat frequency response. For convenience, the normalizing constant A is calculated at a normalizing frequency value fm = 1 Hz with s = j fm, j = √-1. The value of A is given in the poles and zeros table.

CMG-6T CALIBRATION SHEET

WORKS ORDER:	13328	DATE:	19-Jun-2013
SERIAL NUMBER:	T4P98	TESTED BY:	S. Goddard

	Velocity Output V/m/s	Mass Position Output (Acceleration output) $V/m/s^2$	Feedback Coil Constant $Amp/m/s^2$
VERTICAL	2000	405	0.00795
NORTH/SOUTH	1992	454	0.00891
EAST/WEST	2000	412	0.00808

Power Consumption: 5mA @ ±5V input
Calibration Resistor: 51000

NOTE: A factor of 2 x must be used when the sensor outputs are used differentially (also known as push-pull or balanced output). Under no conditions should the negative outputs be connected to the signal ground. A separate signal ground pin is provided.

POLES AND ZEROS TABLE

WORKS ORDER NUMBER: 13328

SENSOR SERIAL NO: T4P98

Velocity response output, Vertical Sensor:

POLES (HZ)	ZEROS HZ
$-23.65 \times 10^{-3} \pm j23.65 \times 10^{-3}$	0
-180	0
-160	
-80	

Normalizing factor at 1 Hz: A = 2304000

Sensor Sensitivity: See Calibration Sheet.

Velocity response output, Horizontal Sensors:

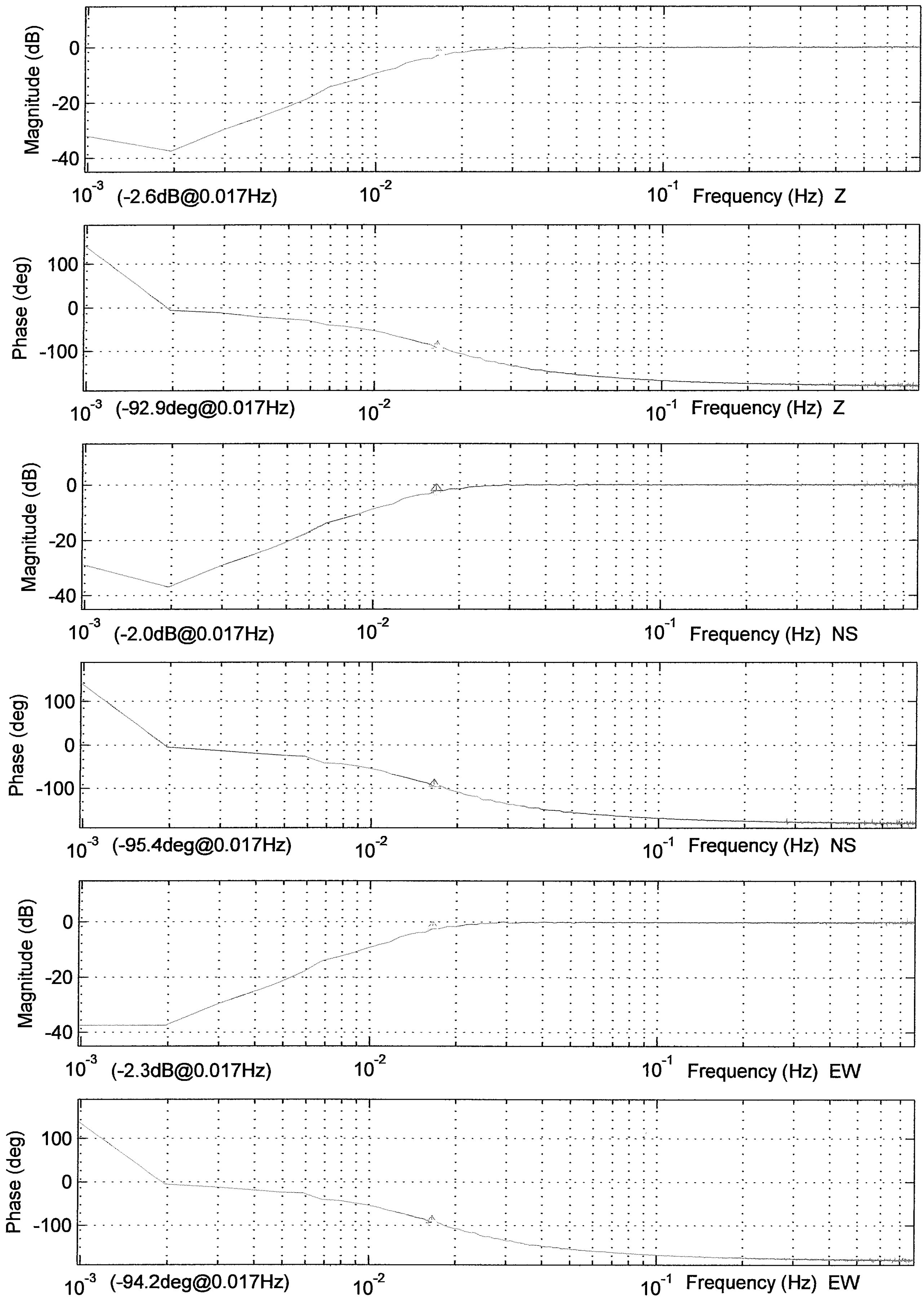
POLES (HZ)	ZEROS (HZ)
$-23.65 \times 10^{-3} \pm j23.65 \times 10^{-3}$	0
-180	0
-160	
-80	

Normalizing factor at 1 Hz: A = 2304000

Sensor Sensitivity: See Calibration Sheet.

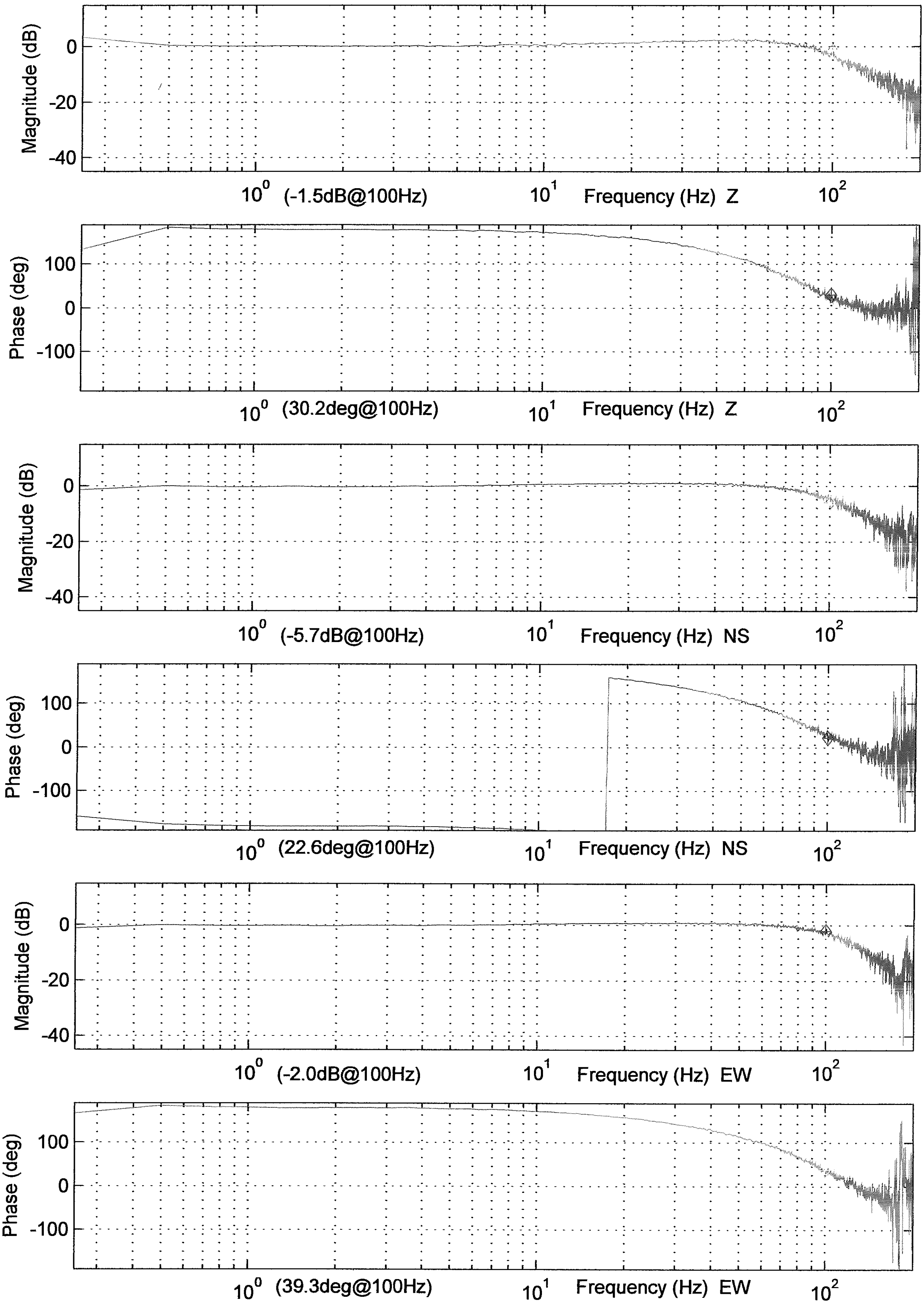
NOTE: The above poles and zeros apply to the vertical and the horizontal sensors and are given in units of Hz. To convert to Radian/sec multiply each pole or zero with 2π. The normalizing factor A should also be recalculated.

Normalized Frequency Response for : T4P98, 13328



18-Jun-2013

Normalized Frequency Response for : T4P98, 13328



18-Jun-2013