

Holbrook-Costa-Rica LC4x4 Generalized Response and Calibration Factor

These calculations are for the generalized case and assume the signal is in the sensor frequency range giving a flat response. Frequency response ranges are indicated.

SENSOR RESPONSE INFO:

For the High-Tech Hydrophone sensitivity:

For the custom High-Tech Hydrophone (HTI-90-U) the manufacturer calibration files give a sensitivity of -182.7 dB re 1V/μPa. This hydrophone loses ~2 dB in sensitivity per ~6000m in depth (10,000 psi) so for typical ocean depth around 3km we correct ~1 dB and use -183.7 dB re 1V/μPa. Using amplitude spectra throughout (e.g. X[db] = 20*log10[X/Xref]), this gives S(hyd-HTI) = 10**(-183.7/20) * 1V/μPa = .653 mV/Pa (@ 3000m water depth). Thus:

S(hyd-HTI) = 0.653 mV/Pa -or- (6.53e-4 V/Pa)

flat response: 0.05 Hz to 7.5 kHz (@ 3000m depth)

Frequency response information:

From Brian Spychalski at High Tech Inc. (personal communication: June 03, 2014):

- 1: HPF at input of preamp created by ceramic element 12.8nF (nom.) and 300 meg ohm resistor (0.04Hz)
- 2: There is another HPF at opamp set at 0.02Hz.
- 3: LPF at opamp is set at 7.5KHz.

Parameter	Nominal Value	Units
Zeros (2)	0 0	Rad/s
Poles (3)	-24.127431 -0.1256637 -47124	Rad/s
Normalization	47124	
Normalization Frequency	500	Hz

For the L28LB tri-axial seismometer sensitivity:

Transduction constant --> 1.57 * sqrt(R-coil) V/m/s with R-coil = 630 ohm nominally this gives 39.53 V/m/s. SIO uses 70% coil current damping, (R-shunt-ss = (7860+51) ohm single-sided, divide by 2 to effective R-shunt damping for differential signal), thus R-shunt-diff = 3956 ohm, which gives:

S(L28) = 34.10 V/m/s

flat response: ~4.5 Hz and above

Frequency response information (for a damped oscillator):

Two zeros at 0, two poles at $\omega_0 \left(\delta \pm i\sqrt{1-\delta^2} \right)$ where $\delta = 0.701$ (damping value).

Parameter	Nominal Value	Units
Zeros (2)	0 0	Rad/s
Poles (2)	19.820 +/- i*20.164	Rad/s
Normalization	-1	
Normalization Frequency	4.5	Hz

ELECTRONICS RESPONSE INFO:

The sensitivity of the A/D is as follows:

With reference filter voltage of V-filt = 100 ohm the voltage range is +/- 2.47 V,

max counts over this range are -Vref = -6,100,300 to +Vref = 6,102,081.

This gives $S(a/d) = 4.94 / 12,202,381 = 0.405 \times 10^{-6} \text{ V/count} = 0.405 \text{ microV/count}$, or:

$S(a/d) = 0.405 \text{ } \mu\text{V/count} \quad \text{-or-} \quad (4.05\text{e-}7 \text{ V/count})$

Note: A/D reaches full 24-bit range (i.e. -8388608 to 8388607) @ overvoltage of +/- 3.3 V. However, the response in this overvoltage range is roughly nonlinear.

Note2: If V-filt = 10 ohm the voltage range is +/- 2.50 V $\rightarrow S(a/d) = 0.410 \text{ microV/count}$.

PRE-AMP GAIN INFO:

Pre-amp gain settings for sensor/channel on OBS deployments were:

gain(hyd-HTI) = 16

gain(L28) = 64

TOTAL SYSTEM RESPONSE INFO:

Total system response then becomes: $S(\text{total}) = S(a/d)/[S(\text{sensor}) * \text{gain}]$

AB & LC4x4 Generalized Total System Response:

AB-SP (4-comp) units:

Hydro-HTI pressure response = 38.76 $\mu\text{Pa/count}$ (~0.05 Hz to 7.5 kHz)
= 3.876e-5 Pa/count

L28 Velocity response = 0.186 (nm/s)/count (~4.5 Hz and above)
= 1.86e-10 (m/s)/count