LC4x4 Generalized Response and Calibration Factor

(Revised: Oct 28, 2010)

These calculations are for the generalized case where we assume that input signal is in the sensor frequency range giving a flat response. Frequency response ranges for various sensors are indicated.

SENSOR RESPONSE INFO:

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) = 10**(-183.7/20) * 1V/µPa = .653 mV/Pa (@ 3000m water depth). Thus:

S(hyd) = 0.653 mV/Pa *flat response: 0.05 Hz to 7.5 kHz (@ 3000m depth)*

For the L22D seismometer sensitivity:
transduction constant --> 1.61 * sqrt(R-coil) V/m/s with R-coil = 510 ohm nominally this gives 36.359 V/m/s. SIO uses 71% coil current damping (R-shunt = 2k ohm) which gives:

S(l22) = 29.0 V/m/s *flat response: ~2 Hz and above*

For the L28LB 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 = 3971k ohm) which gives:

S(l28) = 34.12 V/m/s *flat response: ~4.5 Hz and above*

Note: prior to May, 2009 R-shunt = 1986 ohm {here S(l28) = 30.01 V/m/s}

For the Trillium-40 seismometer sensitivity:
the manufacturer quotes 1500 V*s/m over +/-8V, thus:

S(T40) = 1500 V/m/s *flat response: 0.025 Hz (40 sec) to 50 Hz*

For the Trillium-240 seismometer sensitivity:
the manufacturer quotes 1200 V*s/m over +/-20V, thus:

S(T240) = 1200 V/m/s *flat response: 0.004167 Hz (240 sec) to 35 Hz*

For the DPG sensitivity:
Calibration of the DPG's (Jim Sari at JHU/APL with a 1 psi sensor) gives -186 dB re 1V/microPa, (a 1psi Bell Jar gave ~1 mV/Pa with a variability of a factor of 2), using the same calculation as the hydrophone we get:

S(DPG) = 0.501 mV/Pa *flat response: 0.010 Hz to 10 Hz*

SYSTEM RESPONSE INFO:

The sensitivity of the A/D is as follows: Voltage range: +/- 2.5 V, max counts over this range of -8388608 to 8388607. This gives S(a/d) = 5.0 / 16777215 = 0.298 microV/count, or:

S(a/d) = 0.298 microV/count

So for "unity" response (i.e. NO pre-amp gain):

S(unity) = S(a/d)/S(sensor)

S(hyd-unity)	= 0.456 mPa/count	--> 0.456 * 10**-3 Pa/count
S(L22-unity)	= 10.28 (nm/s)/count	--> 1.028 * 10**-8 (m/s)/count
S(L28-unity)	= 8.734 (nm/s)/count	--> 8.734 * 10**-9 (m/s)/count
S(T40-unity)	= 0.199 (nm/s)/count	--> 1.987 * 10**-10 (m/s)/count
S(T240-unity)	= 0.248 (nm/s)/count	--> 2.483 * 10**-10 (m/s)/count
S(DPG-unity)	= 0.595 mPa/count	--> 0.595 * 10**-3 Pa/count

The "standard" gain settings for each sensor/channel on all LC4x4 OBS deployments are:

gain(hyd)	**= 16**	**gain(DPG)**	**= 1**	
gain(l22)	**= 64**	**gain(T40)**	**= 0.311**	*(VDiv: 3.16k/(3.16k+6.98k))*
gain(l28)	**= 64**	**gain(T240)**	**= 0.125**	*(VDiv: 1k/(6.98k+1k))*

These gain settings are only changed for special deployment or for special requests. When the pre-amp gain is applied to the sensor output the 'effective' gain becomes:

S(sensor-eff) = S(sensor) * gain(preamp)

Total system response then becomes:

S(total)= S(a/d)/S(sensor-eff) = S(unity)/gain(preamp)

Finally, the generalized response and calibration factor for the LC4x4 system with various sensors then becomes:

LC4x4 Generalized System Response:

SP units:

Hydro pressure response	**= 28.5 µPa/count**	*(~0.05 Hz to 7.5 kHz)*
L22 Velocity response	**= 0.161 (nm/s)/count**	*(~2 Hz and above)*
L28 Velocity response*	**= 0.136 (nm/s)/count**	*(~4.5 Hz and above)*
	*{*L28 = 0.155 (nm/s)/count before May 2009}*	

LP units:

Trillium-40 Velocity response	**= 0.639 (nm/s)/count**	*(40 sec to 50 Hz)*
Trillium-240 Velocity response	**= 1.984 (nm/s)/count**	*(240 sec to 35 Hz)*
DPG pressure response	**= 0.595 mPa/count**	*(100 sec to 10 Hz)*