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REPORT ON ACOUSTICAL MEASUREMENTS CONDUCTED FOR

Hong Kong Cetacean Research Project

EQUIPMENT TESTED

Hydrophone on an Environmental Acoustic Recorder (EAR)
EAR S/N : 9300708B088
(B1)

REPORT NUMBER : EARS-001

PREPARED BY: Gus ZHANG Cheng

PREPARED ON: 13th September 2013

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TEST OBJECTIVE

The test objective for this report was designed to reproduce the frequency testing carried for the hydrophone model SQ26-01, fitted to an Environmental Acoustic Recorder (EAR).

The SQ26-01 is manufactured by Sensor Technology Limited, a Canadian Company with an address given as P.O. Box 97, Collingwood, Ontario, Canada L9Y 3Z4. The hydrophone SQ26-01 is described as a general purpose, low-cost electrically shielded hydrophone.

The Environmental Acoustic Recorder (EAR) is supplied by Oceanwide Science Institute with an address given as 3620 Baldwin Ave. Ste 204, Makawao, HI 96768, U.S.A.

MEASUREMENT INSTRUMENTATION

The measurement Instrumentation was comprised of a calibrated hydrophone probe, an Agilent Technologies DSO-X-3024A Digital Oscilloscope, and an 8116A Hewlett Packard Pulse/Function Generator. All results were recorded in a Dell Laptop running Excel.

Two calibrated by-laminar membrane hydrophones were used. One used for the frequency range from 0.1KHz to 20KHz, the other from 15KHz to 50KHz. The overlap of frequency was used to check the calibration of both of the equipment used.

MEASUREMENT SETUP

The 0.1KHz to 20KHz by-laminar membrane hydrophone was connected to the Hewlett Packard Signal Generator. The unit was set to give a single frequency sine wave at a voltage level of 30Vp-p.

The hydrophone on the EAR's unit (model SQ26-01) was electrically disconnected from the electronic circuit and directly connected to the Agilent Digital oscilloscope. The latter was configured to display the signal being received by the hydrophone as well as the Fast Fourier Transformation (FFT) of that signal.

The by-laminar membrane hydrophone was mechanically connected to the top of the SQ26-01 hydrophone.

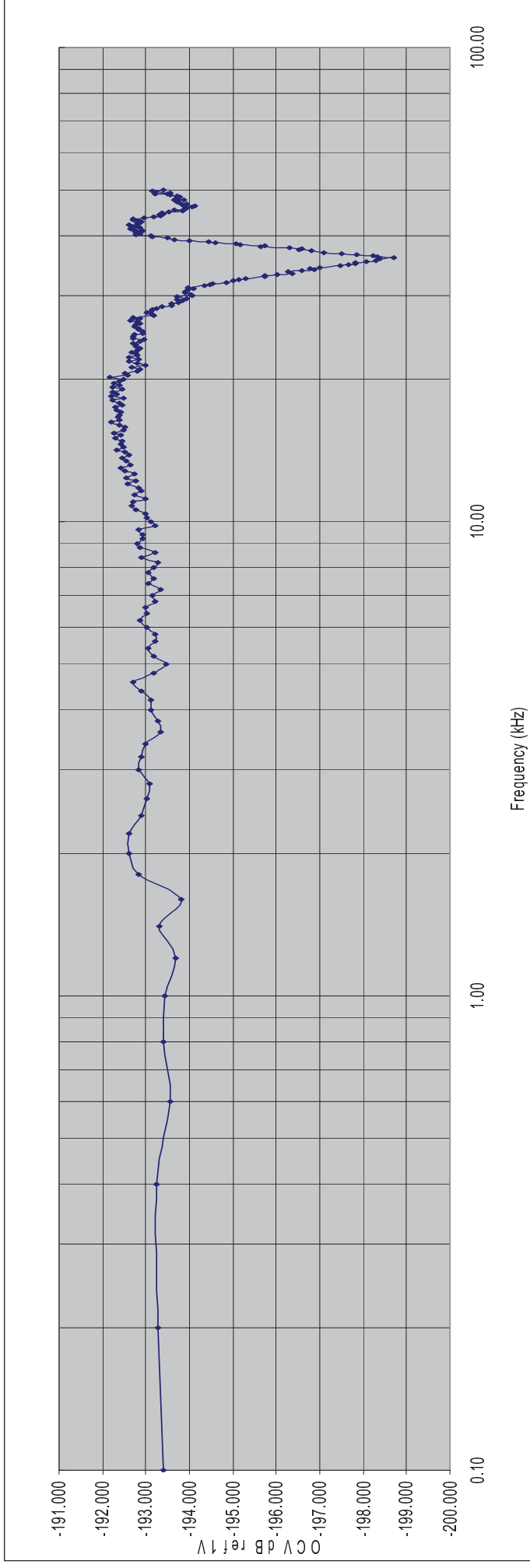
The frequency of the signal Generator was varied in 200Hz graduations through the range of 0.1KHz to 50KHz and the corresponding height of the FFT displayed result was measured using the calibrated internal cursor on the oscilloscope screen. In all a total of 250 readings were taken.

Agilent Technologies DSO-X-3024A serial number : MY52161670

Hewlett Packard Function Generator serial number : 178667-03

RESULTS

The results of the testing for frequencies from 0.1KHz to 50KHz are shown in the Received Voltage Response graph below:



Temperature during the test = 20°C.

Pressure was 1.001mB

Location of test : HKU Laboratory

Date of test = 7th September 2013.

PERFORMANCE STATEMENT

The results of these tests shows that the maximum received frequency attenuation deviation of the SQ26-01 hydrophone fitted to the EAR unit with serial number 9300708B088, as compared to the manufacturers quoted specification (see Appendix A for details) is less than 0.5dBA. This gives a worst case deviation of $<\pm 1$ dBA. This is an acceptable result for such a sensor given the specification quotes a deviation of ± 1 dBA is acceptable (see Appendix A).

Signed :  _____

Date : _13th September 2013.

APPENDIX A - SQ23-01 Data Sheet

The SQ23-01 data sheet showing the frequency attenuation response.



Sensor Technology Limited

Hydrophone

SQ26-01



Features

- Low cost
- Rugged
- Good depth capability

Applications

- General purpose research
- Towed arrays

Overview

The SQ26-01 is a general-purpose low-cost electrically shielded hydrophone. It has good sensitivity, wide bandwidth, and good stability. Custom configurations of these hydrophones are also available. For additional data on frequency response or outline drawings, please call our technical support. All parameters are measured after hydrophones have been subjected to pressures of 70 bar. The polyurethane-encapsulated hydrophone will withstand continuous immersion in isoparaffinic hydrocarbon fluids and sea water.

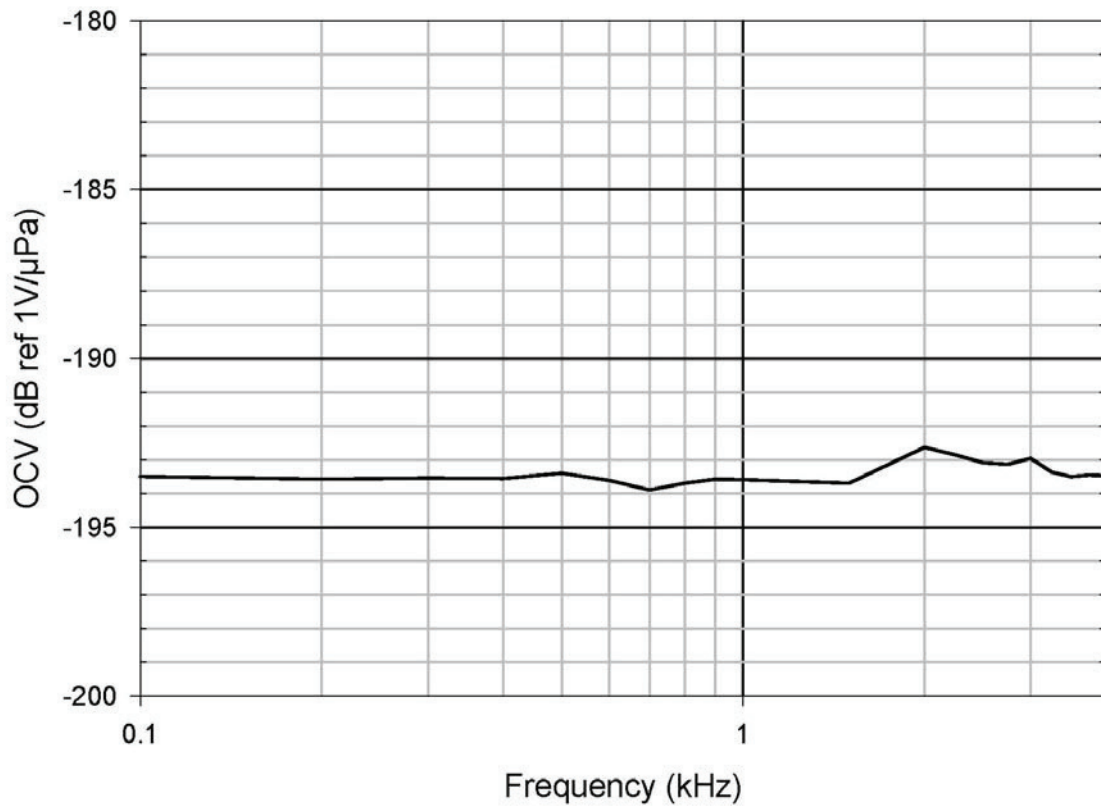
Specifications

Voltage sensitivity	-193.5 ± 1.0 dBV re 1 μPa @ 20 °C, 20 V/bar
Charge sensitivity	24 nC/bar
Capacitance	1.4 nF ± 10 % @ 20 °C
Sensitivity variation with temperature	less than 1 dB loss from 0 to 35 °C
Capacitance variation with temperature	0.33% increase per °C
Capacitance variation with depth	7% loss per 1,000 m
Operating depth	down to 1,000 m
Frequency response	flat from 1 Hz to 28,000 Hz
Acceleration sensitivity	< 0.2 mbar/g when properly mounted
Storage and operating temperature	-30 to +60 °C
Diameter	25.4 mm (1.0")
Length	25.4 mm (1.0") max
Mass	16 grams
Electrical leads	two-wire shielded, 28AWG, 30cm (12") long
Shielding	integral Faraday cage type
Electrical insulation	> 500 M Ohms
Water blocked leads	No

Sensor Technology Limited, PO Box 97, Collingwood Ontario, Canada L9Y 3Z4
 Tel (705) 444-1440 Fax (705) 444-6787 www.Sensortech.ca Email: techsupport@Sensortech.ca

Rev. 09/03

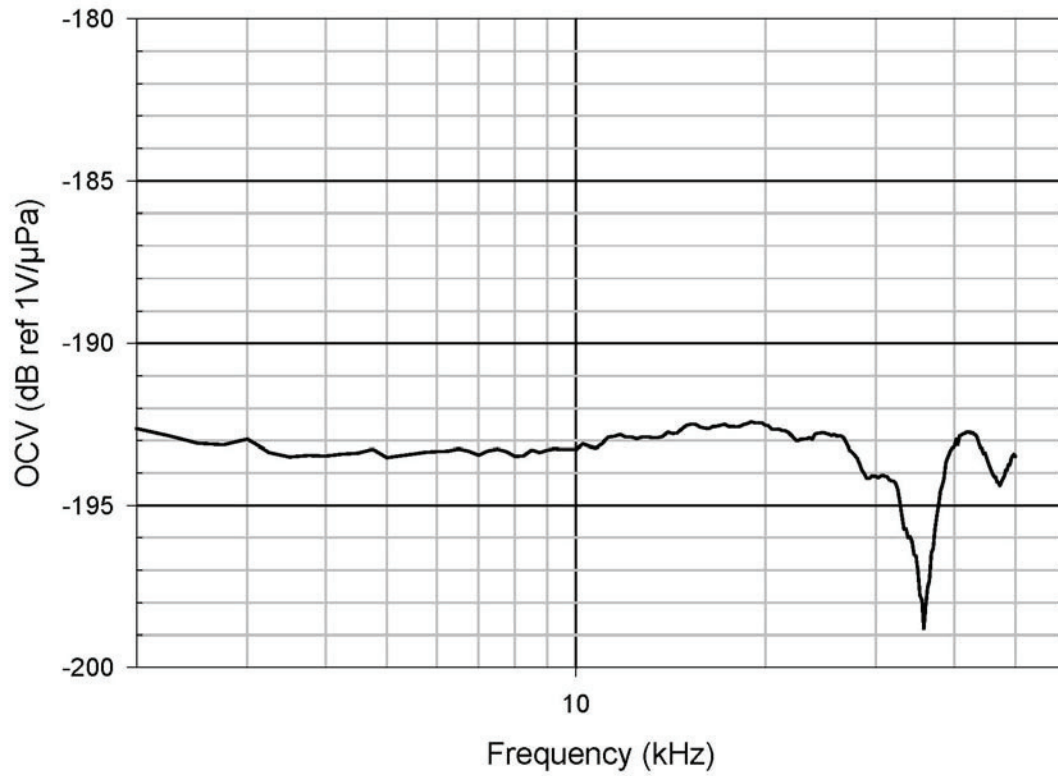
Receive Voltage Response SQ26 (typical)



Date: October 4, 2004
Acoustic Test Facility: Newport Rhode Island
Transducer Model: SQ26
Test Frequency: 100 - 3000Hz
Spacing: 2.32 meters
Depth: 12 meters
Plane: XZ

SENSOR
Sensor Technology Limited

Receive Voltage Response SQ26 (typical)



Date: Sept 16, 2004
Acoustic Test Facility: Seneca Lake Sonar Test Facility
Transducer Model: SQ26
Test Frequency: 2 - 50kHz
Spacing: 2.32 meters
Depth: 12 meters
Plane: XZ



APPENDIX B - Raw Data

The raw data collected during the testing:

Frequency KHz	Log10 (v) dB
0.10	-193.403
0.20	-193.271
0.40	-193.241
0.60	-193.557
0.80	-193.394
1.00	-193.422
1.20	-193.678
1.40	-193.321
1.60	-193.797
1.80	-192.845
2.00	-192.598
2.20	-192.621
2.40	-192.901
2.60	-193.011
2.80	-193.073
3.00	-192.842
3.20	-192.897
3.40	-192.979
3.60	-193.346
3.80	-193.282
4.00	-193.112
4.20	-193.106
4.40	-192.895
4.60	-192.703
4.80	-193.175
5.00	-193.448
5.20	-193.184
5.40	-193.052
5.60	-193.224
5.80	-193.212
6.00	-193.028
6.20	-192.861
6.40	-193.035
6.60	-192.981
6.80	-193.201
7.00	-193.153
7.20	-193.338
7.40	-193.046
7.60	-193.184
7.80	-193.055
8.00	-193.178
8.20	-193.274
8.40	-192.902
8.60	-193.225
8.80	-192.873
9.00	-192.813
9.20	-192.918
9.40	-192.931
9.60	-192.845
9.80	-193.214
10.00	-193.104
10.20	-193.008
10.40	-192.999
10.60	-192.766
10.80	-192.689
11.00	-192.708
11.20	-192.984
11.40	-192.728
11.60	-192.888
11.80	-192.827
12.00	-192.582
12.20	-192.783
12.40	-192.554
12.60	-192.744
12.80	-192.509
13.00	-192.429
13.20	-192.641
13.40	-192.535
13.60	-192.445
13.80	-192.610

Frequency KHz	Log10 (v) dB
14.00	-192.520
14.20	-192.336
14.40	-192.477
14.60	-192.417
14.80	-192.454
15.00	-192.287
15.20	-192.435
15.40	-192.279
15.60	-192.474
15.80	-192.505
16.00	-192.384
16.20	-192.190
16.40	-192.380
16.60	-192.349
16.80	-192.402
17.00	-192.411
17.20	-192.328
17.40	-192.303
17.60	-192.440
17.80	-192.380
18.00	-192.217
18.20	-192.487
18.40	-192.194
18.60	-192.341
18.80	-192.233
19.00	-192.439
19.20	-192.226
19.40	-192.387
19.60	-192.251
19.80	-192.403
20.00	-192.485
20.20	-192.169
20.40	-192.570
20.60	-192.515
20.80	-192.810
21.00	-192.874
21.20	-192.660
21.40	-192.975
21.60	-192.804
21.80	-192.602
22.00	-192.837
22.20	-192.615
22.40	-192.797
22.60	-192.769
22.80	-192.671
23.00	-192.790
23.20	-192.872
23.40	-192.781
23.60	-192.760
23.80	-192.708
24.00	-192.856
24.20	-192.949
24.40	-192.695
24.60	-192.714
24.80	-192.748
25.00	-192.939
25.20	-192.916
25.40	-192.843
25.60	-192.824
25.80	-192.735
26.00	-192.766
26.20	-192.865
26.40	-192.809
26.60	-192.656
26.80	-192.854
27.00	-192.709
27.20	-193.172
27.40	-193.148
27.60	-193.035
27.80	-193.119

Frequency KHz	Log10 (v) dB
28.00	-193.161
28.20	-193.244
28.40	-193.373
28.60	-193.578
28.80	-193.589
29.00	-193.736
29.20	-193.831
29.40	-193.713
29.60	-193.925
29.80	-193.702
30.00	-194.070
30.20	-194.016
30.40	-193.893
30.60	-193.896
30.80	-193.976
31.00	-194.104
31.20	-193.959
31.40	-194.362
31.60	-194.479
31.80	-194.547
32.00	-194.844
32.20	-195.025
32.40	-195.137
32.60	-195.290
32.80	-195.729
33.00	-195.733
33.20	-196.015
33.40	-196.356
33.60	-196.283
33.80	-196.582
34.00	-196.882
34.20	-196.784
34.40	-196.985
34.60	-197.486
34.80	-197.665
35.00	-197.824
35.20	-197.827
35.40	-198.077
35.60	-198.298
35.80	-198.398
36.00	-198.697
36.20	-198.311
36.40	-198.217
36.60	-197.842
36.80	-197.493
37.00	-197.080
37.20	-196.823
37.40	-196.529
37.60	-196.597
37.80	-196.315
38.00	-195.656
38.20	-195.731
38.40	-195.181
38.60	-195.073
38.80	-194.599
39.00	-194.453
39.20	-194.009
39.40	-193.661
39.60	-193.499
39.80	-193.158
40.00	-193.125
40.20	-192.755
40.40	-192.864
40.60	-192.753
40.80	-192.807
41.00	-192.930
41.20	-192.695
41.40	-192.646
41.60	-192.876
41.80	-192.662

Frequency KHz	Log10 (v) dB
42.00	-192.790
42.20	-192.597
42.40	-192.832
42.60	-192.787
42.80	-192.909
43.00	-192.809
43.20	-192.817
43.40	-192.710
43.60	-192.702
43.80	-192.962
44.00	-193.165
44.20	-193.335
44.40	-193.299
44.60	-193.386
44.80	-193.380
45.00	-193.517
45.20	-193.826
45.40	-193.651
45.60	-193.903
45.80	-193.950
46.00	-193.905
46.20	-194.049
46.40	-194.121
46.60	-193.841
46.80	-193.944
47.00	-193.775
47.20	-193.707
47.40	-193.704
47.60	-193.658
47.80	-193.874
48.00	-193.679
48.20	-193.726
48.40	-193.764
48.60	-193.712
48.80	-193.561
49.00	-193.498
49.20	-193.222
49.40	-193.552
49.60	-193.225
49.80	-193.157
50.00	-193.390



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REPORT ON ACOUSTICAL MEASUREMENTS CONDUCTED FOR

Hong Kong Cetacean Research Project

EQUIPMENT TESTED

Hydrophone on an Environmental Acoustic Recorder (EAR)
EAR S/N : 9300479B100
(B2)

REPORT NUMBER : EARS-002

PREPARED BY: Gus ZHANG Cheng

PREPARED ON: 13th September 2013

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TEST OBJECTIVE

The test objective for this report was designed to reproduce the frequency testing carried for the hydrophone model SQ26-01, fitted to an Environmental Acoustic Recorder (EAR).

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The Environmental Acoustic Recorder (EAR) is supplied by Oceanwide Science Institute with an address given as 3620 Baldwin Ave. Ste 204, Makawao, HI 96768, U.S.A.

MEASUREMENT INSTRUMENTATION

The measurement Instrumentation was comprised of a calibrated hydrophone probe, an Agilent Technologies DSO-X-3024A Digital Oscilloscope, and an 8116A Hewlett Packard Pulse/Function Generator. All results were recorded in a Dell Laptop running Excel.

Two calibrated by-laminar membrane hydrophones were used. One used for the frequency range from 0.1KHz to 20KHz, the other from 15KHz to 50KHz. The overlap of frequency was used to check the calibration of both of the equipment used.

MEASUREMENT SETUP

The 0.1KHz to 20KHz by-laminar membrane hydrophone was connected to the Hewlett Packard Signal Generator. The unit was set to give a single frequency sine wave at a voltage level of 30Vp-p.

The hydrophone on the EAR's unit (model SQ26-01) was electrically disconnected from the electronic circuit and directly connected to the Agilent Digital oscilloscope. The latter was configured to display the signal being received by the hydrophone as well as the Fast Fourier Transformation (FFT) of that signal.

The by-laminar membrane hydrophone was mechanically connected to the top of the SQ26-01 hydrophone.

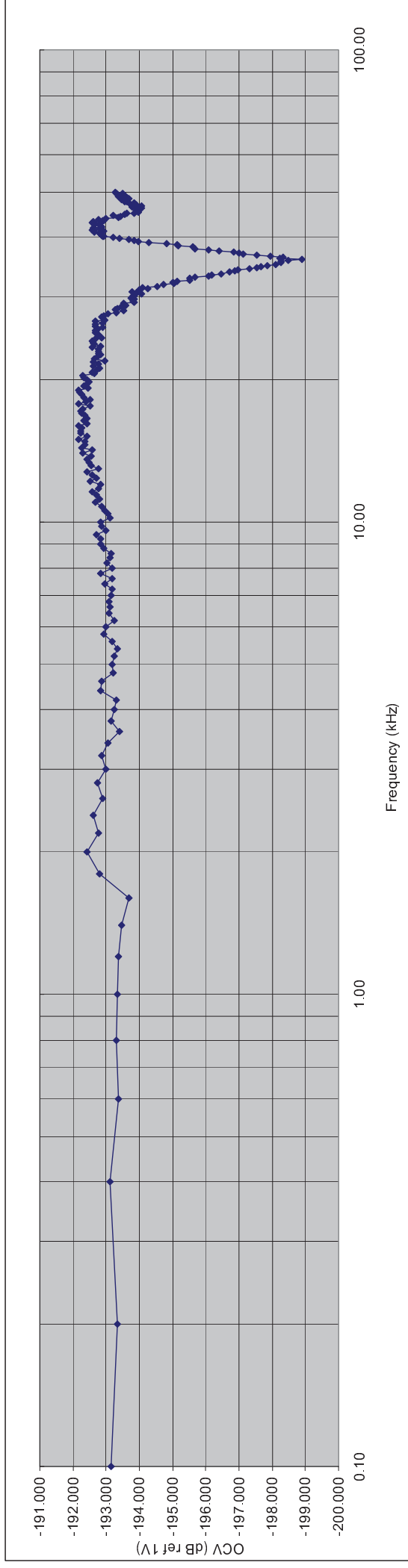
The frequency of the signal Generator was varied in 200Hz graduations through the range of 0.1KHz to 50KHz and the corresponding height of the FFT displayed result was measured using the calibrated internal cursor on the oscilloscope screen. In all a total of 251 readings were taken.

Agilent Technologies DSO-X-3024A serial number : MY52161670

Hewlett Packard Function Generator serial number : 178667-03

RESULTS

The results of the testing for frequencies from 0.1KHz to 50KHz are shown in the Received Voltage Response graph below:



Temperature during the test = 20°C.

Pressure was 1.003mB

Location of test : HKU Laboratory

Date of test = 10th September 2013.

PERFORMANCE STATEMENT

The results of these tests shows that the maximum received frequency attenuation deviation of the SQ26-01 hydrophone fitted to the EAR unit with serial number 9300479B100, as compared to the manufacturers quoted specification (see Appendix A for details) is less than 0.4dBA. This gives a worst case deviation of $<\pm 1$ dBA. This is an acceptable result for such a sensor given the specification quotes a deviation of ± 1 dBA is acceptable (see Appendix A).

Signed :  _____

Date : 13th September 2013

APPENDIX A - SQ23-01 Data Sheet

The SQ23-01 data sheet showing the frequency attenuation response.



Sensor Technology Limited

Hydrophone

SQ26-01



Features

- Low cost
- Rugged
- Good depth capability

Applications

- General purpose research
- Towed arrays

Overview

The SQ26-01 is a general-purpose low-cost electrically shielded hydrophone. It has good sensitivity, wide bandwidth, and good stability. Custom configurations of these hydrophones are also available. For additional data on frequency response or outline drawings, please call our technical support. All parameters are measured after hydrophones have been subjected to pressures of 70 bar. The polyurethane-encapsulated hydrophone will withstand continuous immersion in isoparaffinic hydrocarbon fluids and sea water.

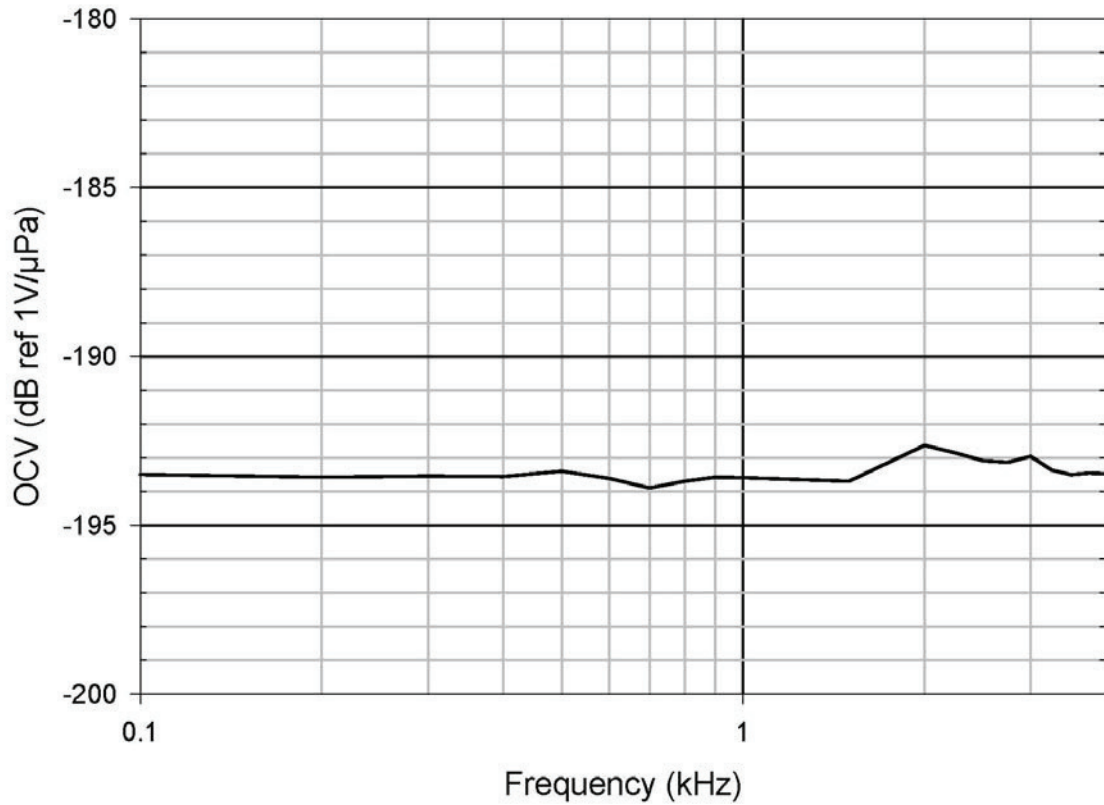
Specifications

Voltage sensitivity	-193.5 ± 1.0 dBV re 1 μPa @ 20 °C, 20 V/bar
Charge sensitivity	24 nC/bar
Capacitance	1.4 nF ± 10 % @ 20 °C
Sensitivity variation with temperature	less than 1 dB loss from 0 to 35 °C
Capacitance variation with temperature	0.33% increase per °C
Capacitance variation with depth	7% loss per 1,000 m
Operating depth	down to 1,000 m
Frequency response	flat from 1 Hz to 28,000 Hz
Acceleration sensitivity	< 0.2 mbar/g when properly mounted
Storage and operating temperature	-30 to +60 °C
Diameter	25.4 mm (1.0")
Length	25.4 mm (1.0") max
Mass	16 grams
Electrical leads	two-wire shielded, 28AWG, 30cm (12") long
Shielding	integral Faraday cage type
Electrical insulation	> 500 M Ohms
Water blocked leads	No

Sensor Technology Limited, PO Box 97, Collingwood Ontario, Canada L9Y 3Z4
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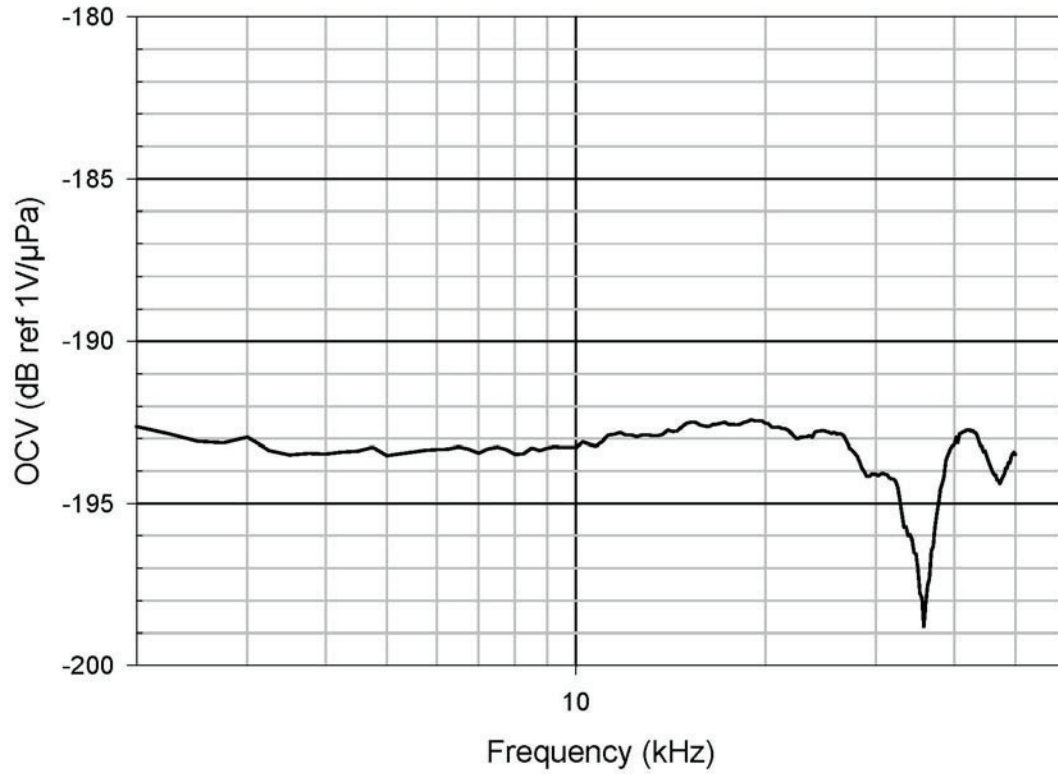
Receive Voltage Response SQ26 (typical)



Date: October 4, 2004
Acoustic Test Facility: Newport Rhode Island
Transducer Model: SQ26
Test Frequency: 100 - 3000Hz
Spacing: 2.32 meters
Depth: 12 meters
Plane: XZ

SENSOR
Sensor Technology Limited

Receive Voltage Response SQ26 (typical)



Date: Sept 16, 2004
Acoustic Test Facility: Seneca Lake Sonar Test Facility
Transducer Model: SQ26
Test Frequency: 2 - 50kHz
Spacing: 2.32 meters
Depth: 12 meters
Plane: XZ

SENSOR
Sensor Technology Limited

APPENDIX B - Raw Data

The raw data collected during the testing:

Frequency KHz	Log10 (v) dB
0.100	-193.134
0.200	-193.349
0.400	-193.114
0.600	-193.356
0.800	-193.320
1.000	-193.341
1.200	-193.370
1.400	-193.478
1.600	-193.684
1.800	-192.800
2.000	-192.409
2.200	-192.780
2.400	-192.603
2.600	-192.908
2.800	-192.737
3.000	-192.988
3.200	-192.851
3.400	-193.045
3.600	-193.408
3.800	-193.151
4.000	-193.238
4.200	-193.300
4.400	-192.845
4.600	-192.856
4.800	-193.219
5.000	-193.164
5.200	-193.234
5.400	-193.322
5.600	-193.177
5.800	-192.918
6.000	-192.993
6.200	-193.230
6.400	-193.080
6.600	-193.103
6.800	-193.082
7.000	-193.154
7.200	-193.174
7.400	-192.946
7.600	-193.178
7.800	-192.828
8.000	-193.170
8.200	-193.027
8.400	-193.112
8.600	-193.149
8.800	-192.921
9.000	-192.833
9.200	-192.818
9.400	-192.690
9.600	-192.982
9.800	-192.859
10.000	-192.825
10.200	-193.130
10.400	-193.040
10.600	-192.961
10.800	-192.869
11.000	-192.685
11.200	-192.790
11.400	-192.712
11.600	-192.575
11.800	-192.771
12.000	-192.824
12.200	-192.525
12.400	-192.701
12.600	-192.570
12.800	-192.424
13.000	-192.782
13.200	-192.536
13.400	-192.495
13.600	-192.416
13.800	-192.563

Frequency KHz	Log10 (v) dB
14.000	-192.293
14.200	-192.567
14.400	-192.274
14.600	-192.353
14.800	-192.372
15.000	-192.159
15.200	-192.416
15.400	-192.242
15.600	-192.235
15.800	-192.269
16.000	-192.154
16.200	-192.411
16.400	-192.334
16.600	-192.410
16.800	-192.351
17.000	-192.271
17.200	-192.240
17.400	-192.290
17.600	-192.512
17.800	-192.155
18.000	-192.391
18.200	-192.500
18.400	-192.337
18.600	-192.251
18.800	-192.186
19.000	-192.167
19.200	-192.445
19.400	-192.342
19.600	-192.429
19.800	-192.489
20.000	-192.428
20.200	-192.331
20.400	-192.303
20.600	-192.648
20.800	-192.575
21.000	-192.692
21.200	-192.789
21.400	-192.610
21.600	-192.753
21.800	-192.619
22.000	-192.946
22.200	-192.652
22.400	-192.739
22.600	-192.830
22.800	-192.779
23.000	-192.766
23.200	-192.777
23.400	-192.577
23.600	-192.847
23.800	-192.648
24.000	-192.619
24.200	-192.563
24.400	-192.676
24.600	-192.848
24.800	-192.756
25.000	-192.780
25.200	-192.683
25.400	-192.669
25.600	-192.744
25.800	-192.904
26.000	-192.679
26.200	-192.674
26.400	-192.897
26.600	-192.679
26.800	-192.946
27.000	-192.906
27.200	-192.863
27.400	-192.936
27.600	-193.068
27.800	-193.319

Frequency KHz	Log10 (v) dB
28.000	-193.526
28.200	-193.260
28.400	-193.341
28.600	-193.449
28.800	-193.576
29.000	-193.522
29.200	-193.833
29.400	-193.798
29.600	-193.852
29.800	-193.749
30.000	-193.779
30.200	-193.830
30.400	-194.057
30.600	-193.921
30.800	-193.789
31.000	-194.000
31.200	-194.263
31.400	-194.096
31.600	-194.534
31.800	-194.718
32.000	-195.050
32.200	-195.012
32.400	-195.149
32.600	-195.528
32.800	-195.516
33.000	-195.678
33.200	-196.071
33.400	-196.176
33.600	-196.466
33.800	-196.717
34.000	-196.858
34.200	-196.959
34.400	-197.301
34.600	-197.523
34.800	-197.652
35.000	-197.850
35.200	-198.104
35.400	-198.270
35.600	-198.277
35.800	-198.473
36.000	-198.884
36.200	-198.246
36.400	-198.323
36.600	-197.958
36.800	-197.543
37.000	-197.135
37.200	-196.988
37.400	-196.846
37.600	-196.396
37.800	-196.097
38.000	-195.666
38.200	-195.605
38.400	-195.172
38.600	-195.144
38.800	-194.835
39.000	-194.277
39.200	-193.983
39.400	-193.829
39.600	-193.696
39.800	-193.386
40.000	-193.195
40.200	-192.936
40.400	-192.886
40.600	-192.876
40.800	-192.838
41.000	-192.795
41.200	-192.650
41.400	-192.922
41.600	-192.572
41.800	-192.827

Frequency KHz	Log10 (v) dB
42.000	-192.597
42.200	-192.870
42.400	-192.817
42.600	-192.816
42.800	-192.680
43.000	-192.574
43.200	-192.597
43.400	-192.925
43.600	-192.892
43.800	-192.773
44.000	-192.977
44.200	-193.356
44.400	-193.446
44.600	-193.209
44.800	-193.559
45.000	-193.629
45.200	-193.845
45.400	-193.956
45.600	-193.981
45.800	-193.919
46.000	-193.975
46.200	-194.059
46.400	-193.863
46.600	-193.780
46.800	-194.056
47.000	-193.917
47.200	-193.722
47.400	-193.827
47.600	-193.635
47.800	-193.564
48.000	-193.548
48.200	-193.477
48.400	-193.681
48.600	-193.571
48.800	-193.623
49.000	-193.375
49.200	-193.553
49.400	-193.324
49.600	-193.312
49.800	-193.489
50.000	-193.265