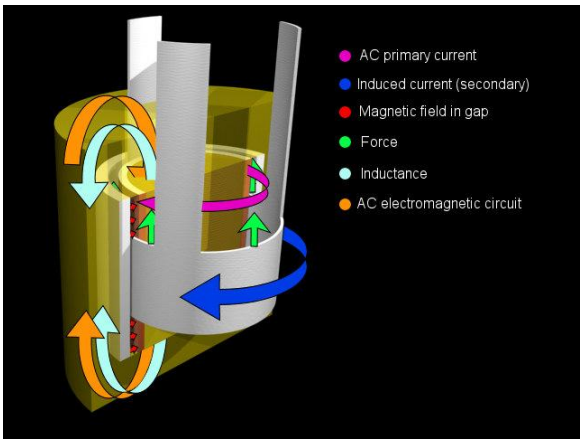
Very Loud Voice Hailer using Induction Driver

Abstract: The Loud Hailer was tested outdoors at long distances for SPL, frequency response and intelligibility. The induction drive compression driver (ALMA 2010) was fitted with a rear chamber and a phase plug and assembled to a 20 x 30 degree horn. A near field measurement was made and EQ was performed using HiQNet System Architect achieving +/-3 dB from 200 to 3800 Hz. The Loud Hailer was determined to be intelligible at 220 Meters.

Preparing the Loud Hailer for outdoor long distance testing and measurement.

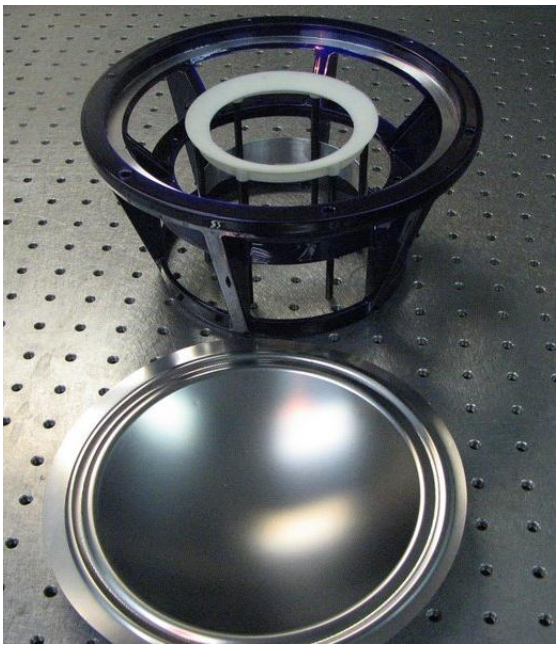
The induction drive compression driver previously described (ALMA 2010) was fitted with a rear chamber and a phase plug and assembled to a 20 x 30 degree horn.

The working principles of the induction motor as applied in the new designs are as follows:



A primary coil induces large currents into a single turn secondary, an aluminum tube.

The secondary is immersed in a static magnetic field, and drives the diaphragm. The magnetic circuit is fabricated using powdered iron, to optimize both static and alternating current coupling



Above, photo of the CID Ti dome diaphragm, frame, and secondary

Below is the phase plug, a Smith style with a ratio of 10:1.

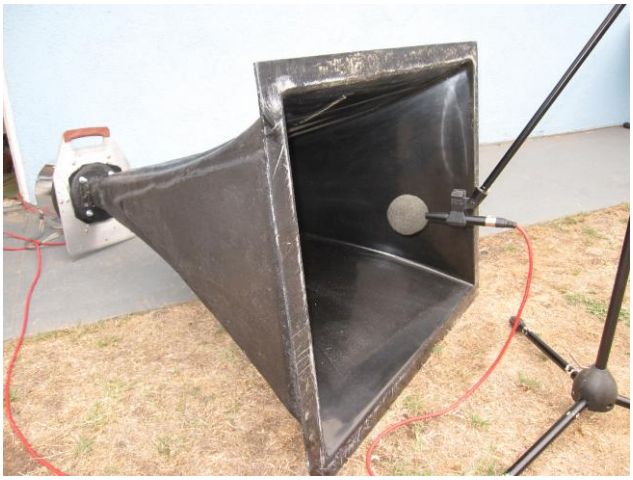
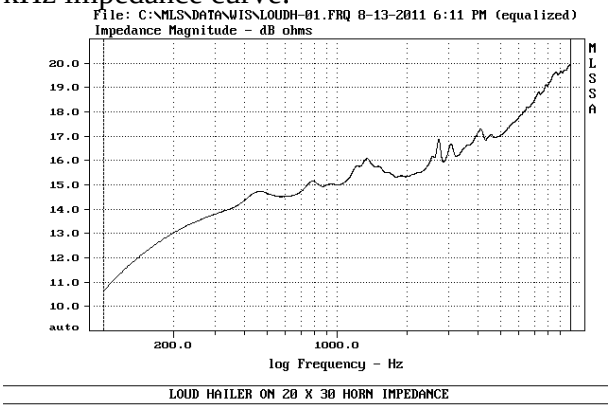


Photo above shows microphone measurement in horn mouth for initial testing and EQ. A DPA 4007 microphone was calibrated and used with a Symmetrix SX202 preamp into a MLSSA system. The horn was powered with one channel of a Crown DSi 4000 power amplifier.
The following graph shows the 100 Hz to 10 kHz impedance curve:



The average impedance is about 16 Ohms.
The graph below shows the unequalized Third Octave frequency response at the horn mouth

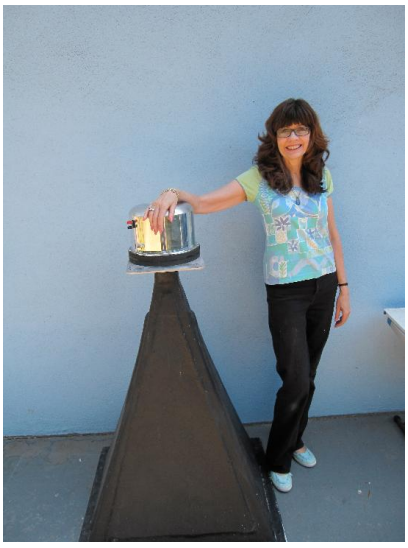
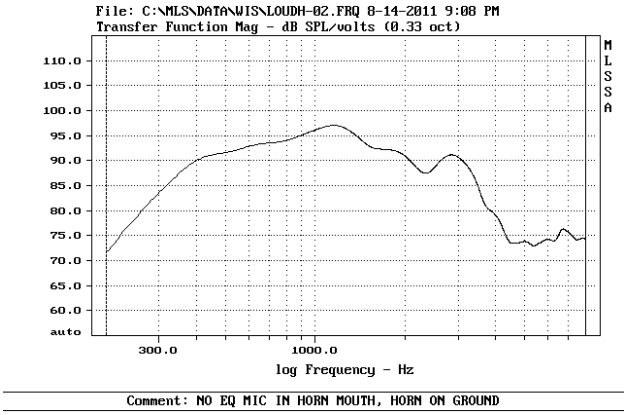
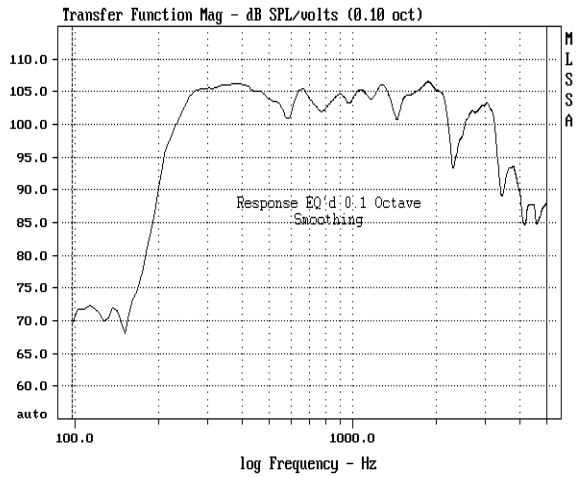


Photo shows relative size of loud hailer next to 5 ft 8 in. wife.

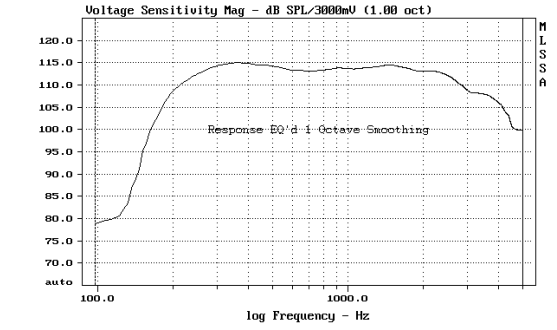


Below the graph shows the equalized response smoothed to 0.1 octave



The band limiting and equalization was accomplished using HiQNet System Architect to control the DSP in the DSi 4000.

Below is the Sensitivity Frequency Response smoothed to 1 Octave.



A casual listening test at low levels using News Radio as a source showed that the Loud Hailer sounded crisp and balanced in the voice range.
After correcting for impedance and distance,, the 1 W/1M sensitivity is 107 dB.

Field Testing

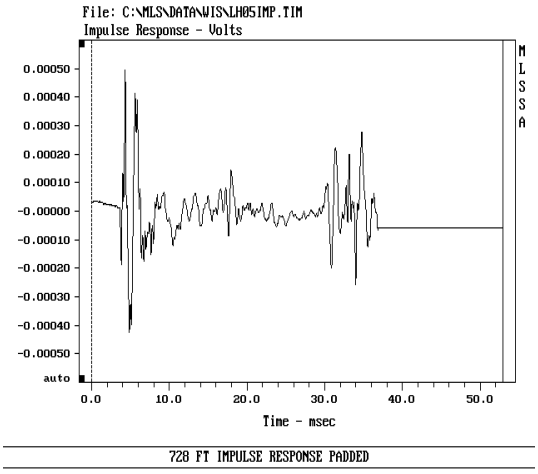
A series of tests was performed outdoors, including measuring the SPL at 77 and 220 Meters using various levels of power into the driver.
Frequency response and intelligibility were also measured.

A location for the test was chosen in an industrial park in Valencia, CA which has long, wide streets and access to a power outlet.

A 1000 foot CAT 6 cable was terminated with BNC connectors on two pairs, as well as audio baluns on two additional pairs.
A Bruel & Kjaer 4189 Deltatron microphone and preamp was used, and powered by an Endevco Model 133 Signal Conditioner and constant current 4 ma source. The current source had no difficulty performing over the 26 Ohms of series resistance in the CAT 6 cable run.

The power amp was a Crown Dsi4000 with HiQnet DSP set to the previous EQ.
A DRA Labs MLSSA 2000 system was used to make the measurements.

In addition to the mic on the long cable, a second method was also used to collect the response data. A laptop with a USB audio adaptor and a measurement mic was carried to various distances, and MLS bursts were recorded with Adobe Audition for later analysis with MLSSA.



The impulse response above was edited to move it forward in time and zeros added to pad the tail of the response to make it suitable for measuring speech transmission index. Un- edited, the impulse started at about 645 msec of delay, corresponding to a 220 Meter path length. There is one large reflection from a building seen at about 30 msec after the direct sound, one smaller one. For this measurement, the mic was on a 24 inch stand.

The speech transmission index (STI) was calculated from the impulse response by MLSSA. Despite the distance, wind, and reflections, the result showed that the hailer exhibits excellent speech intelligibility. Casual listening to news radio verified the high intelligibility of the Hailer at 220 M.

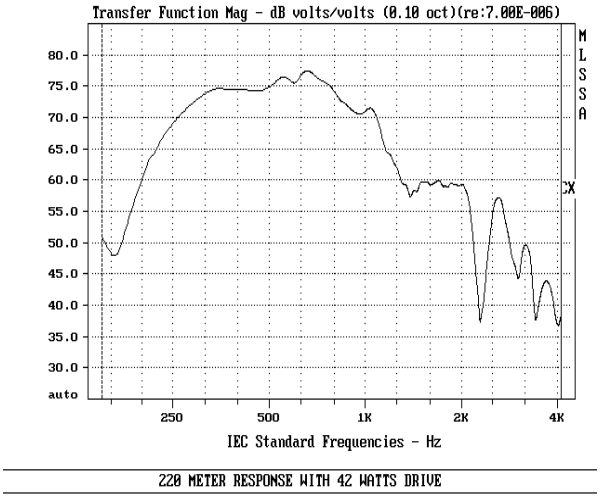
MTF Matrix (Uncalibrated)

Frequency-Hz	125	250	500	1000	2000	4000	8000
level dB-SPL	18.9	25.6	33.5	31.1	24.2	22.8	
m-correction	1.000	1.000	1.000	0.999	0.998	1.000	
0.63	0.990	0.993	0.997	0.998	0.997	0.999	
0.80	0.986	0.991	0.996	0.997	0.996	0.998	
1.00	0.981	0.988	0.995	0.996	0.995	0.998	
1.25	0.975	0.985	0.992	0.994	0.993	0.997	
1.60	0.964	0.980	0.989	0.991	0.989	0.995	
2.00	0.950	0.974	0.983	0.987	0.984	0.992	
2.50	0.930	0.965	0.975	0.981	0.975	0.988	
3.15	0.899	0.954	0.962	0.971	0.962	0.982	
4.00	0.852	0.937	0.942	0.954	0.941	0.972	
5.00	0.788	0.915	0.912	0.931	0.909	0.957	
6.30	0.692	0.884	0.866	0.894	0.858	0.933	
8.00	0.549	0.839	0.793	0.836	0.777	0.898	
10.00	0.365	0.785	0.695	0.757	0.661	0.853	
12.50	0.146	0.720	0.563	0.649	0.494	0.798	
octave MTI	0.775	0.894	0.881	0.901	0.874	0.936	

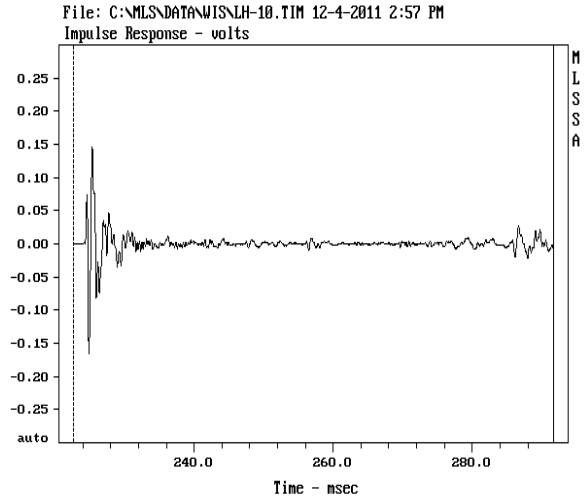
STI value= 0.756 (0.897 modified) ALcons= 2.8% Rating= EXCELLENT

Speech Transmission Index at 220 M 42 Watts Drive

Below is the frequency response at 220 M.

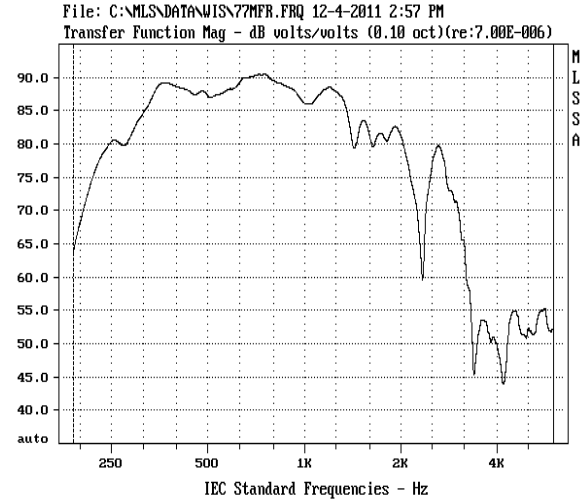


220 METER RESPONSE WITH 42 WATTS DRIVE



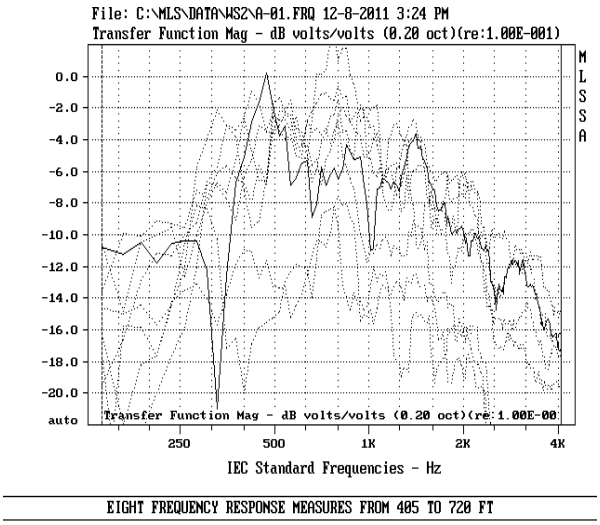
77 M IR

The graph below shows the frequency response at 77M with the mic in GP configuration.

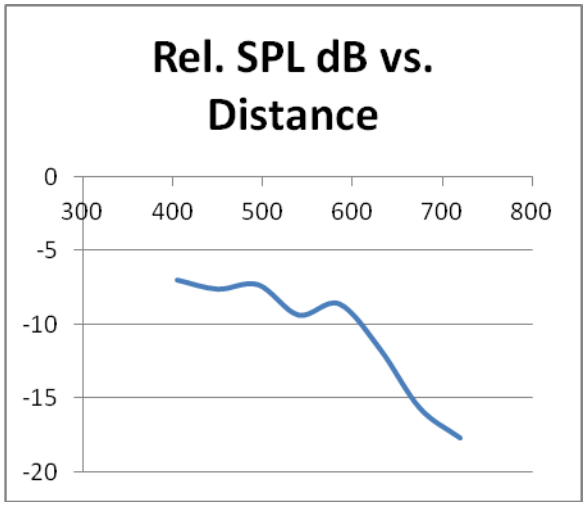


RESPONSE AT 77 METERS 150 WATTS DRIVE

The response at 77 M was measured with the B&K mic on the cat 6 cable on the ground with 150 Watts drive. Below is the impulse response.



Response measures with Laptop System



The graph above charts the relative SPL levels with distance, based on calculations from the Laptop System.

Further Development s

Three improvements could be implemented which could each add 3 dB to the maximum output level:

1. Ferrofluid cooling of the secondary.
2. A Beryllium lightweight diaphragm.
3. A phase plug with 40 to one compression ratio.

Also, a more directional horn could add much more than the 9 dB expected from these three changes. A 5 degree horn would have a directivity index of 32 dB up 13.7 dB from the current DI of 18.4 dB from the 20 x 30 degree horn.

Incorporating all these changes would add 22 dB, to the output. translating to 95 dB at 500 Meters.

The horn could be redesigned as a re-entrant style in order to reduce the length to less than half.

It is planned to send the Hailer to NWAA Labs in Elma, WA for more controlled testing by Ron Sauro. The NWAA testing facility takes advantage of the spaces available in the never commissioned SATSOP nuclear power plant, including indoor distances of 600 ft and five foot thick concrete walls.

Summary and Conclusions

This publication documents the first outdoor tests performed on this induction compression driver on a horn. As this device is still under development, it constitutes a report on work in progress. As it is, it is able to project a highly intelligible voice well in excess of 200 Meters with 42 Watts of input.

With the improvements outlined above the range should be increased to 1000 Meters or more.

Compared to the competition, this device has much more output in the 200 Hz range of the male voice.

Patents are pending and licensees who can partner in further development are welcome to apply for consideration.

References

1. **New Induction Drive Transducer Designs.** Buck, Marshall, Turnmire, Patrick and Graebener, David. Audio Engineering Society 126th Convention Paper , October 9, 2009.
2. **An Improved Beryllium Dome Diaphragm Assembly For Large Format Compression Drivers.** Marshall Buck,1 Gordon Simmons,2 and Sam Saye31 Psychotechnology, Inc, 2 Brush-Wellman, Fremont, CA 94538, USA. Manuscript and Presentation at Audio Engineering Society Convention, October, 2010
3. **A High Performance Beryllium Dome Diaphragm Assembly For Large Format Compression Drivers.** Marshall Buck1, Peter Andrews2, Gordon Simmons2 and Sam Saye2 . Manuscript and Presentation at ALMA International Convention, January 7, 2011. 1 Psychotechnology, Inc, Los Angeles, CA 90034, USA 2 Brush-Wellman, Fremont, CA 94538, USA