NMRA 2015 National Convention Clinic

Measure your diesel horn *Robert Frey*

Part 1A: This clinic shows how to measure the continuous (RMS) sound level of your Diesel Horn with a Sound Level Meter. There is a proper way to report your dB Sound Meter results to others.

Part 2A: Measuring the true (RMS) voltage driven by a DCC Sound Decoder into a speaker system. Then calculating the wattage of the measured (RMS) voltage based on the impedance of your speaker(s) (4, 8, 16, or 32 ohms).

This clinic starts with a handout showing the procedure.

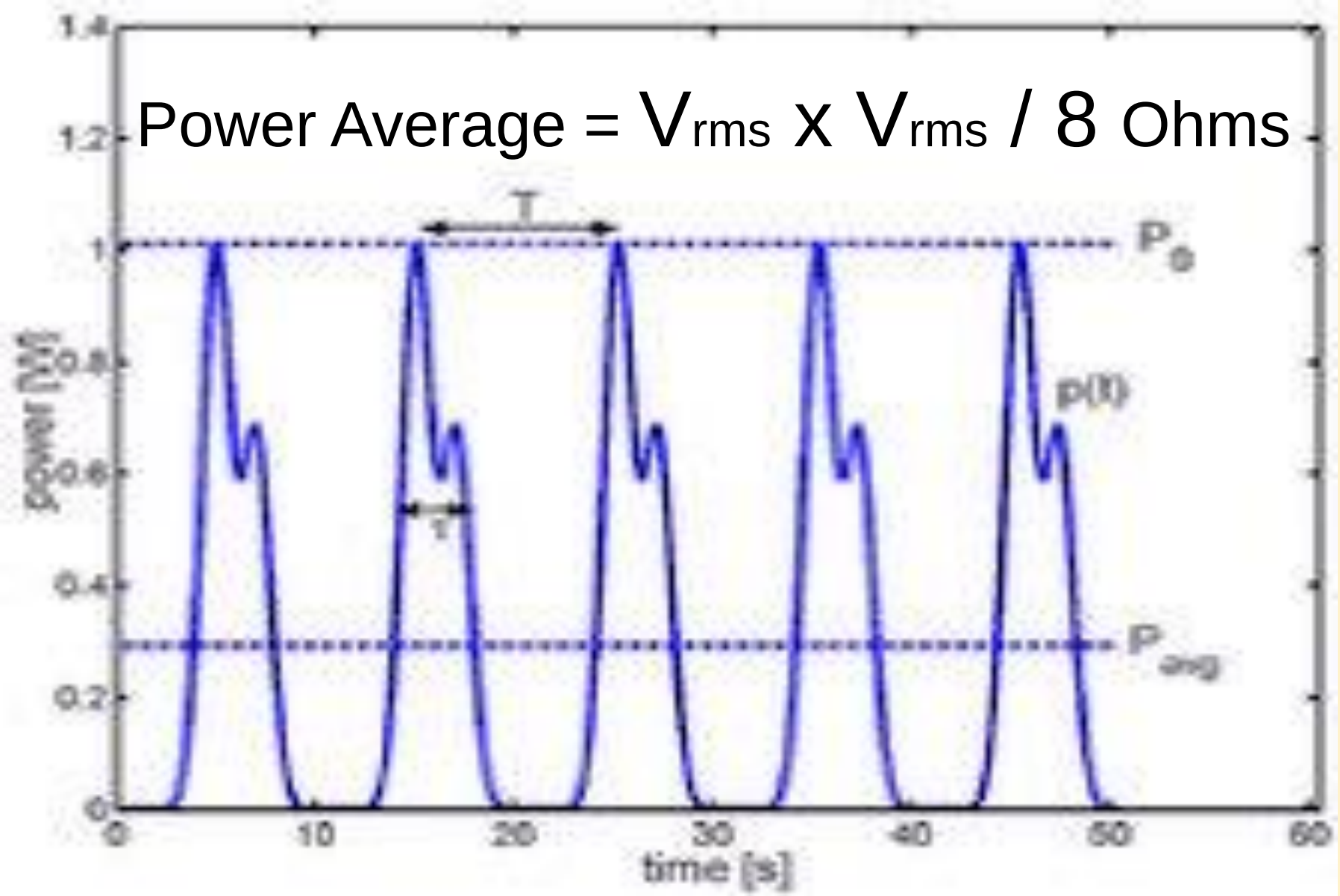
Why Measure your Diesel Horn?

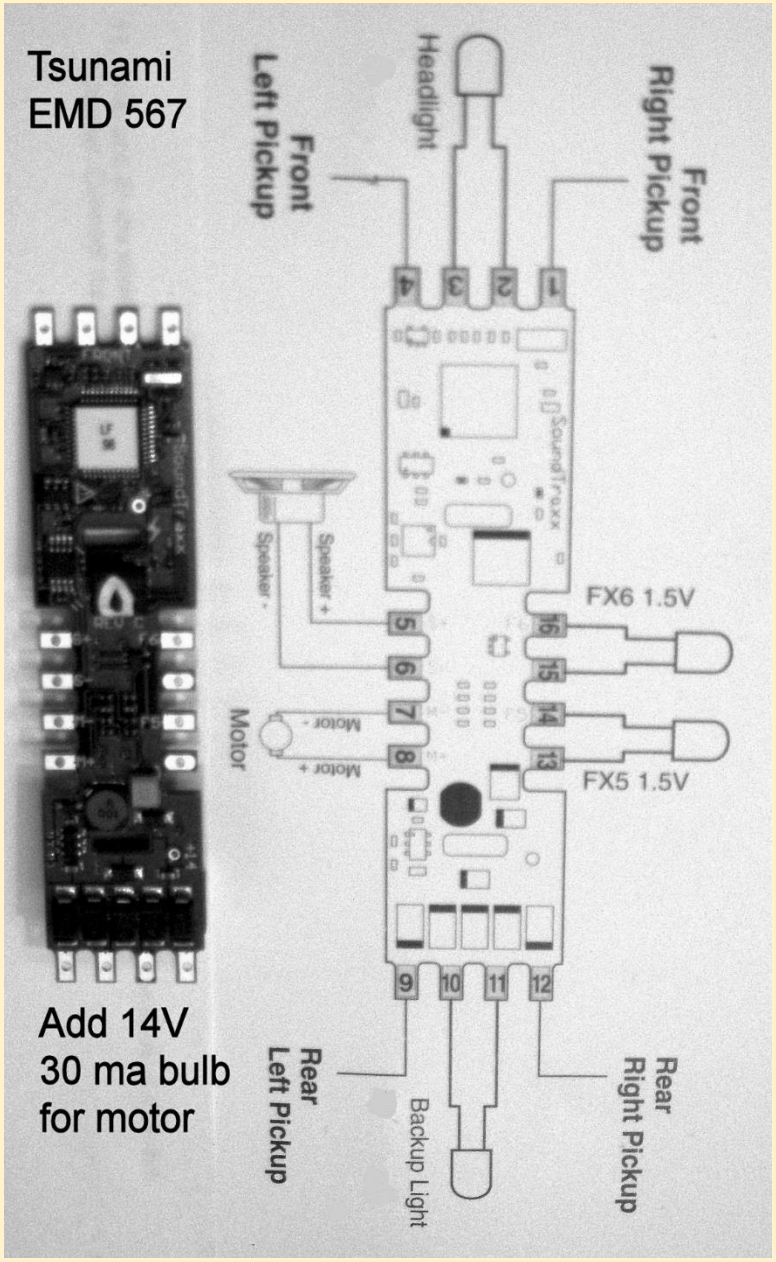
***Problem* 1**: I started with a Digitrax a SDH164D decoder and a 32 ohm speaker. (Hard to find 32, but 8 ohm speakers were easy to find.) With 8 ohm speaker, I blew my horn, it burned out the sound in my decoder. Need for true RMS measurement, and calculate the Watts.

***Problem* 2:** All sound Decoders have adjustable Volumes. Amplifiers have **V**p limit. Increasing the RMS sound level, is keep increasing *CV's* sound volumes. The **V**p limit is where the peaks of your Diesel Horn becomes distorted and sounds funny. (This is known as Clipping.)

***Problem* 3:** Develop a consistency with all your sound decoder installations. Just like we adjust our speed ranges, sound should be normalized too.

No.1: *Measure Horn Watts on an 8 Ohm Speaker*





The 14 Volt 30 ma. bulb indicates when there is any motor voltage, without making any sound. Add your 8 ohm speaker, and a small cable for your True RMS meter.

Note: To read any CV's from your programing track, you will *need* a motor load.

Turn on the ***Low*** Range.

A switch= On

*M*ax.= Off

S switch= On

(slow exponential response)

Sound meter on a stool at 4 feet from speaker.

http://www.amazon.com

American-Recorder

$70 & FREE Shipping

Large LCD display

Two mode settings-

low 35-100 dB

high 65-130 dB

Data hold & max hold

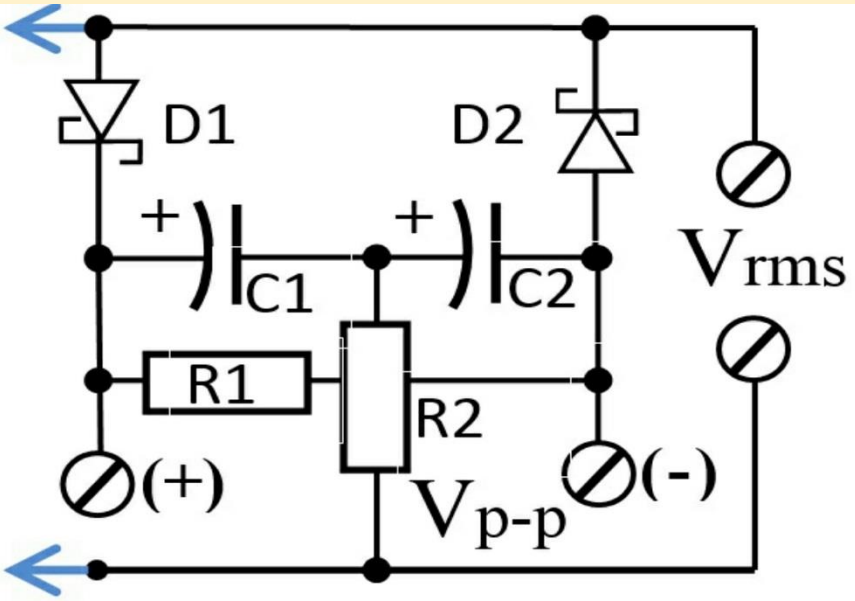
A & C weightings

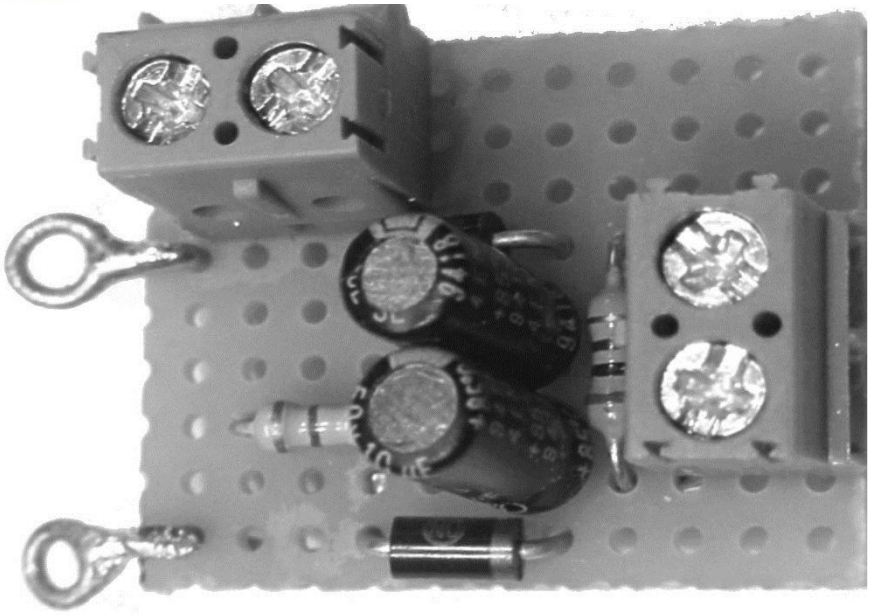
Include 9V battery

http://www.amazon.com

- Tekpower TP40 6000 Counts True RMS Digital AC/DC Auto Range Digital Multimeter $44
- AC+DC True RMS (Root Mean Square) Measurements
- Auto and Manual Ranging
- All the ranges are fused
- Auto power off (could be disabled) & LED Back-lit LCD display with a maximum reading of 5,999

Measure Voltage Peak to Peak

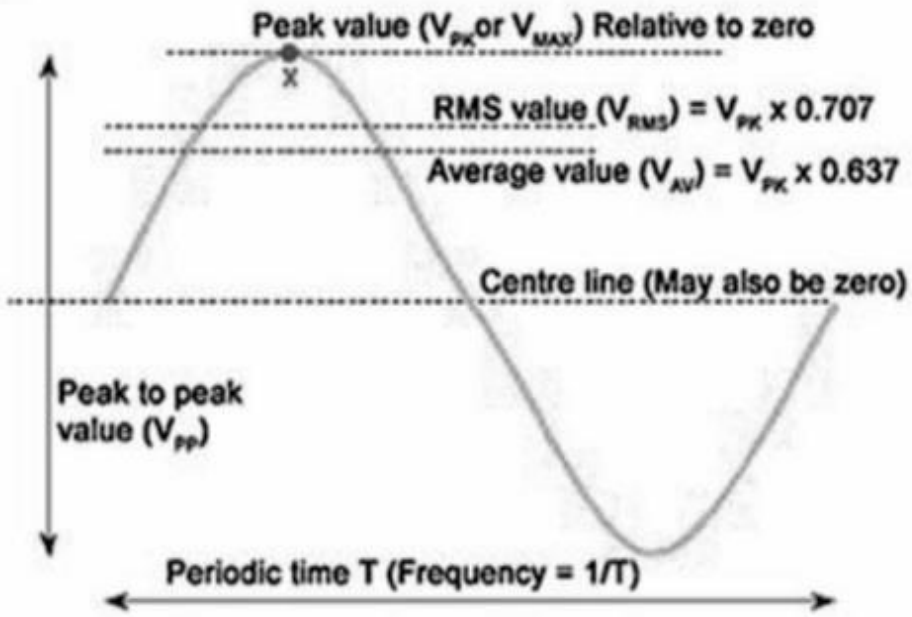




Part No. http://www.digikey.com/

MBR160GOS-ND D1, D2
DIODE SCHOTTKY 60V 1A AXIAL
P10316-ND C1, C2
CAP ALUM 10UF 50V 20% RADIAL
CF14JT1M00CT-ND R1
RES 1M OHM 1/4W 5% CARBON FILM
CF14JT220RCT-ND R2
RES 220 OHM 1/4W 5% CARBON FILM
277-1667-ND Vp-p and Vrms
TERM BLOCK PCB 2POS 5.0MM
340K-ND
BREADBOARD 1/16"DIA 2.00X4.50"

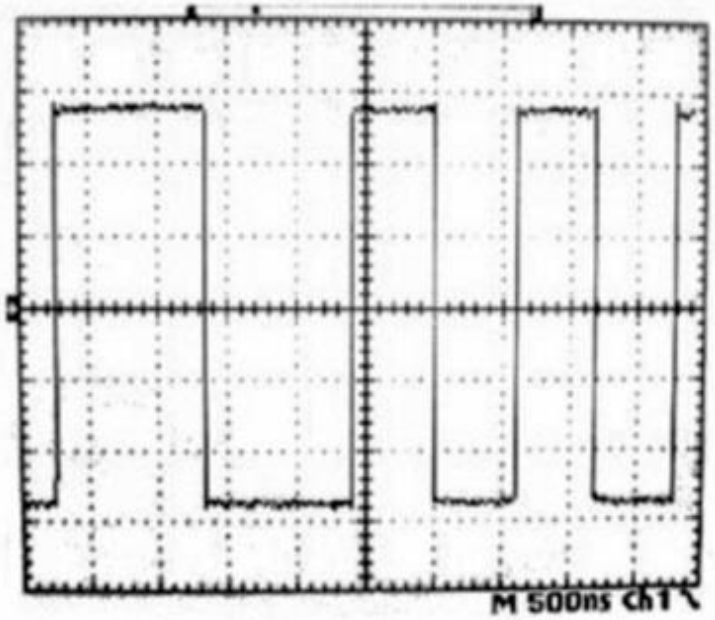
A Schottky diode has a low forward voltage drop and a fast switching action.



That 1 Vrms sinewave has a peak voltage of 1.414 V, and a peak-to-peak voltage of 2.828 V

Vrms	Vp-p	Diodes	2.828 x Vrms
24.0	67.1	0.80	67.9
12.0	33.3	0.60	33.9
6.0	16.4	0.50	16.9
3.0	8.04	0.40	8.48
1.50	3.90	0.35	4.25
0.80	1.96	0.30	2.26
0.40	0.88	0.25	1.13
0.20	0.37	0.20	0.57

DCC Track Voltage: 14.4 Vrms, 28.8 Vp-p



1.0 Vrms sinewave or square wave applied across a 1.0 Ω resistor produces 1.0 Watt of heat.

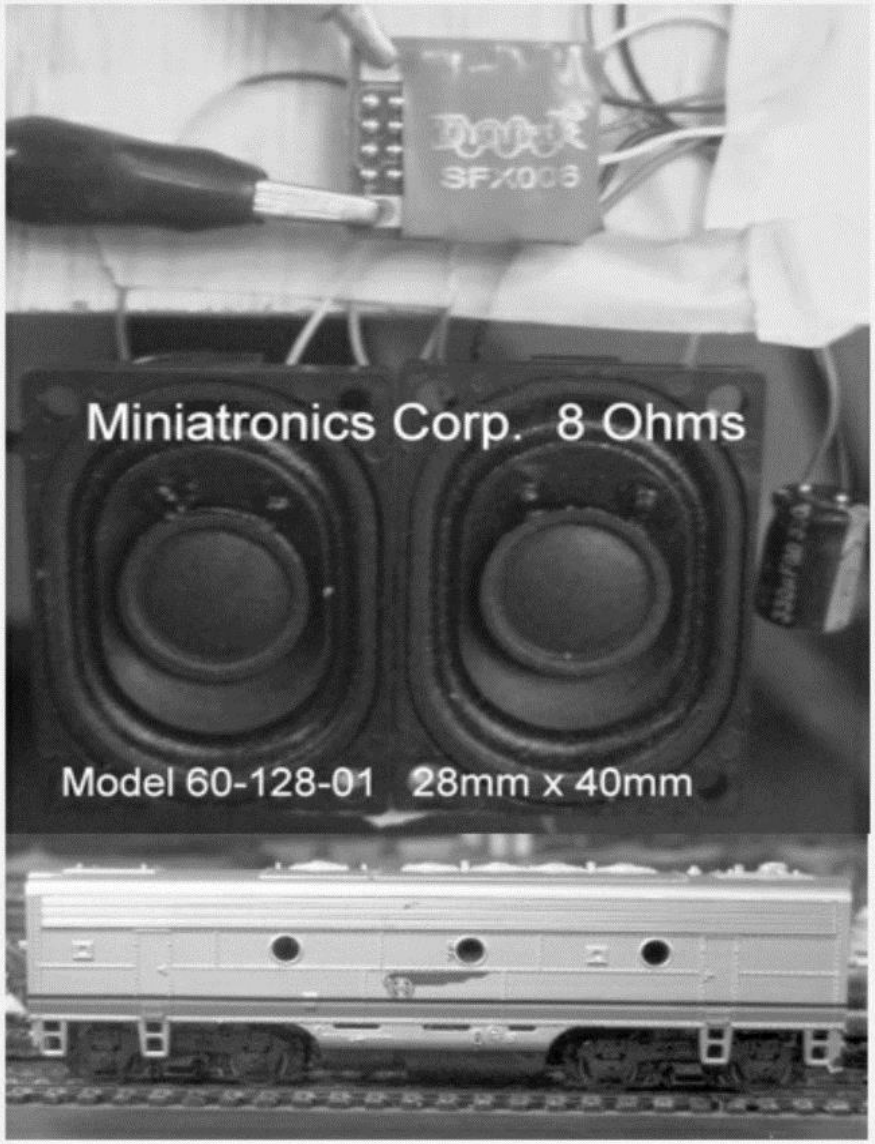
The DCC Track Voltage measure 28.2 Volts DC peak to peak with the Vp-p voltage tester. Add 0.6 for the diodes drop and this is 28.8 Vp-p. Divide by 2 and you get 14.4 Volts true rms, for a square wave!

Tsunami by Soundtrax EMD 567

CV128	**dB**A@4'	Vp-p
Idle	**52**	2.40
192	**69**	4.45
228	**70**	5.05
254	**72**	5.30
H+Run	**73**	5.55
Vr/Vp	41%	47%
CV128	Vrms	Watts
Idle	0.54	0.04
192	0.91	0.11
228	1.05	0.14
254	1.16	0.15
H+Run	1.31	0.21

Digitrax SFX006 Soundbug Diesel Horn 4 Ohms

CV58	dBA@4'	Vp-p
Idle	**46**	0.60
9	**67**	3.45
12	**70**	4.50
15	**72**	4.60
H+Run	**72**	4.65
Vr/Vp	50%	68%
CV58	Vrms	Watts
Idle	0.27	0.02
9	0.86	0.19
12	1.21	0.37
15	1.44	0.52
H+Run	1.56	0.61



Measure your diesel horn

Part 1B:

This clinic will now show you some information on the continuous sound levels of a Diesel Horn and others sounds with a Sound Level Meter using the **dB**(A) Scale.

2015 NMRA Convention By Robert Frey

Hearing at 0 dB

- The threshold of hearing is generally reported as the RMS sound pressure of 20 micropascals, or 0.98 pW/m2 It is approximately the quietest sound a young human with undamaged hearing can detect at 1,000 Hz.
- **The standard threshold of hearing at 1000 Hz is nominally taken to be 0 dB.**

dB	Vrms	Watts	Pa
80	3.00	1.125	0.2
78	2.51	0.788	
76	2.00	0.500	
74	1.41	0.249	
72	1.26	0.198	
70	1.00	0.125	70 dB(A)
68	0.71	0.062	Horn @4'
66	0.63	0.050	(To loud?)
64	0.50	0.031	
62	0.32	0.013	
60	0.30	0.011	0.02
50	0.10	0.0013	
40	0.030	0.0001	0.002
30	0.010	0.0000	
20	0.003		0.0002
10	0.001		
0	0 dB = RMS sound pressure of 20 micropascals,		0.00002

Your Speaker: Power in, Sound Out

The RMS voltage into your speaker, with a moving cone, produces a sound output.

- A sound level meter or sound meter is an instrument that measures sound pressure level on a **dB** Scale.
- The AC signal from the microphone of the sound level meter is converted to a DC number by a root-mean-square (RMS) circuit. The DC is converted to a **dB** number based on the scale selected.

Sound Level Meters

Lo Scale: 30 to 90 dB Hi Scale: 75 to 130 dB

decibel (dB)

- The decibel (dB) is a logarithmic unit used to express the ratio between two values of a physical quantity, often power. The number of decibels is ten times the logarithm to base 10
- The output of the RMS circuit is linear in voltage and is passed through a logarithmic circuit to give a readout linear in decibels (dB)

Meter Display

* FAST is RMS in 35 ms (fluctuating noise)
* SLOW is RMS in 1 sec. (Normally used)
* Lo= 30-100 dB Range
* The dB(A) is the “A” frequency-weighting
* HOLD number, or the MAX reading.

Measurement Considerations

1. Background Noise

If the level difference between the absence and presence of the sound is **10 dB** or more the influence of the ground noise may be disregarded.

2. Reflection

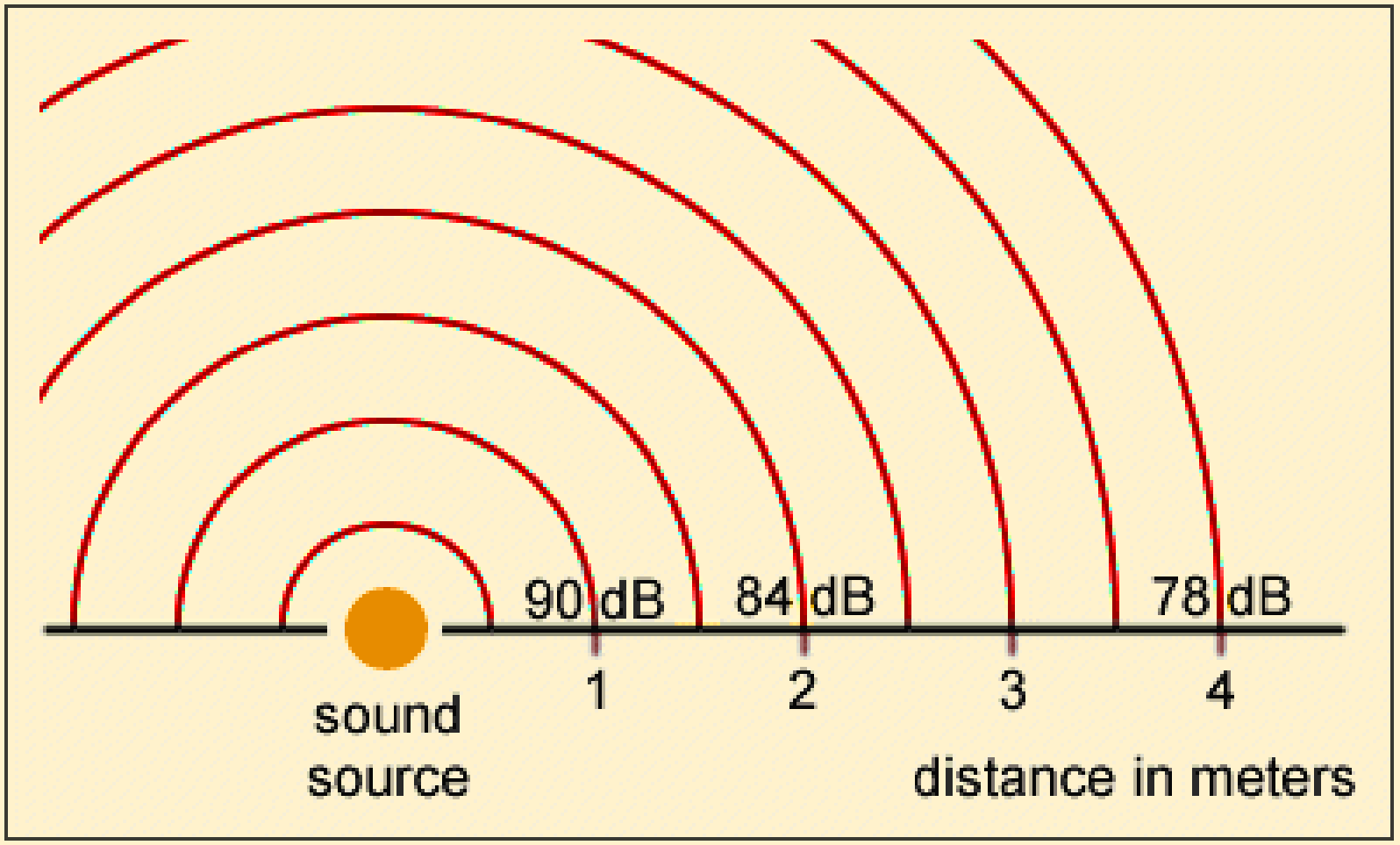
The microphone should be placed well away from reflected surfaces. Hold meter at arms length. This will help to avoid reflections from your body.

3. Best if nothing obstructs the noise source.

(Diesel Horn: before installed, speaker hanging by its wires, After Installed, locomotive is a noise source.)

dB must be reported at a distance

When distance doubles is a -6 dB change.



The Use of Locomotive Horns

https://www.fra.dot.gov/Page/P0105

Under the Train Horn Rule (49 CFR Part 222), locomotive engineers must begin to sound train horns at least 15 seconds, and no more than 20 seconds, in advance of all public grade crossings. If a train is traveling faster than 60 mph, engineers will not sound the horn until it is within ¼ mile of the crossing.

http://www.gpo.gov/fdsys/pkg/CFR-2014-title49-vol4/pdf/CFR-2014-title49-vol4-sec229-129.pdf

sound of train horns compliance

Title 49 → Subtitle B → Chapter II → Part 229 → Subpart C → §229.129 Locomotive horn

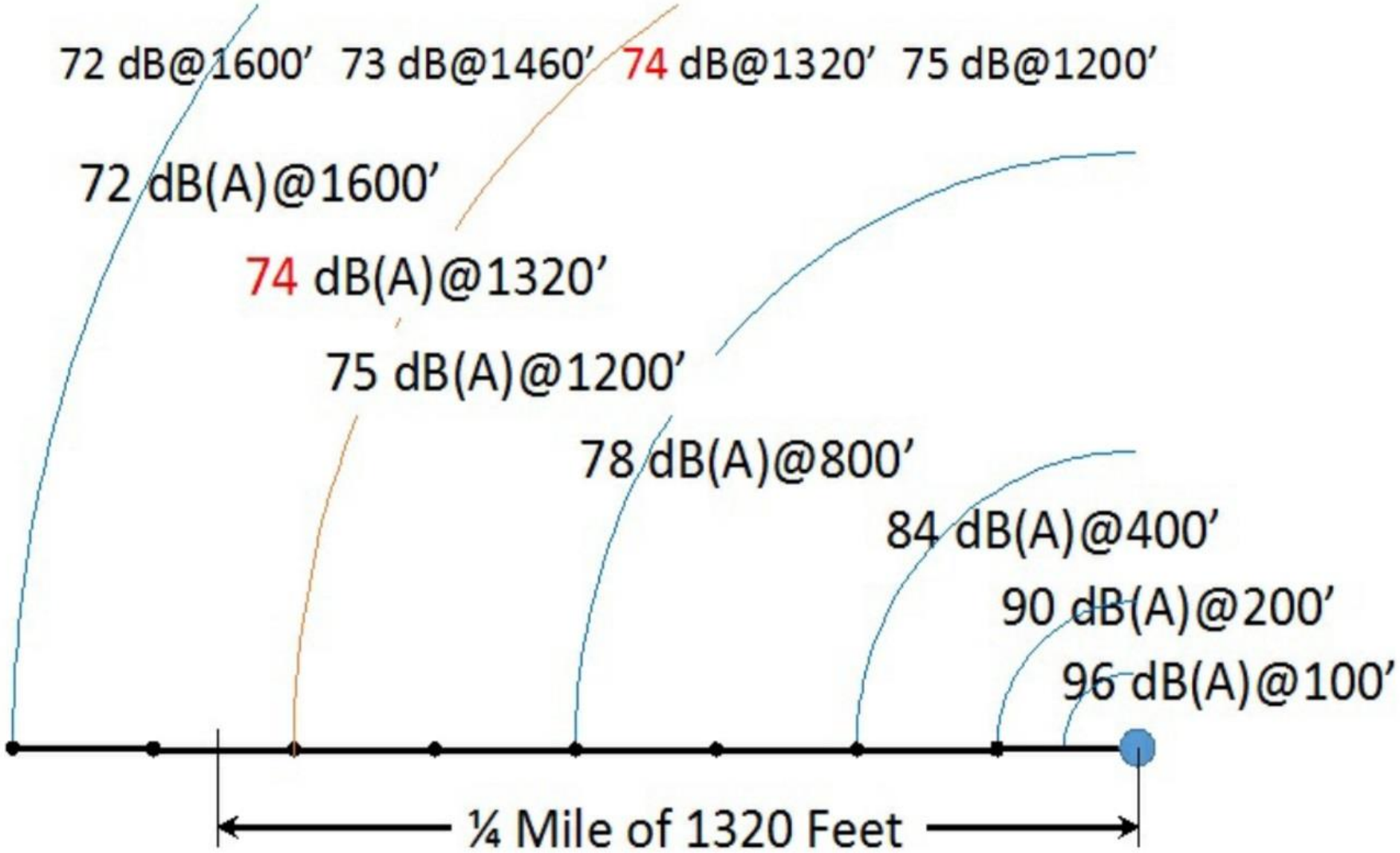
Each lead locomotive shall be equipped with a locomotive horn that produces a minimum sound level of 96 dB(A) and a maximum sound level of 110 dB(A) at 100 feet.....

(3) Each remanufactured locomotive shall be tested in compliance with paragraph (a).

(8) Background noise shall be minimal: the sound level at the test site immediately before and after each horn sounding event shall be at least 10 dB(A) below the level measured during the horn sounding.

(9) *Measurement procedures.* The sound level meter shall be set for A-weighting with slow exponential response ……..at least six such 10-second duration readings shall be used to determine compliance.

Diesel Horn at the Crossing



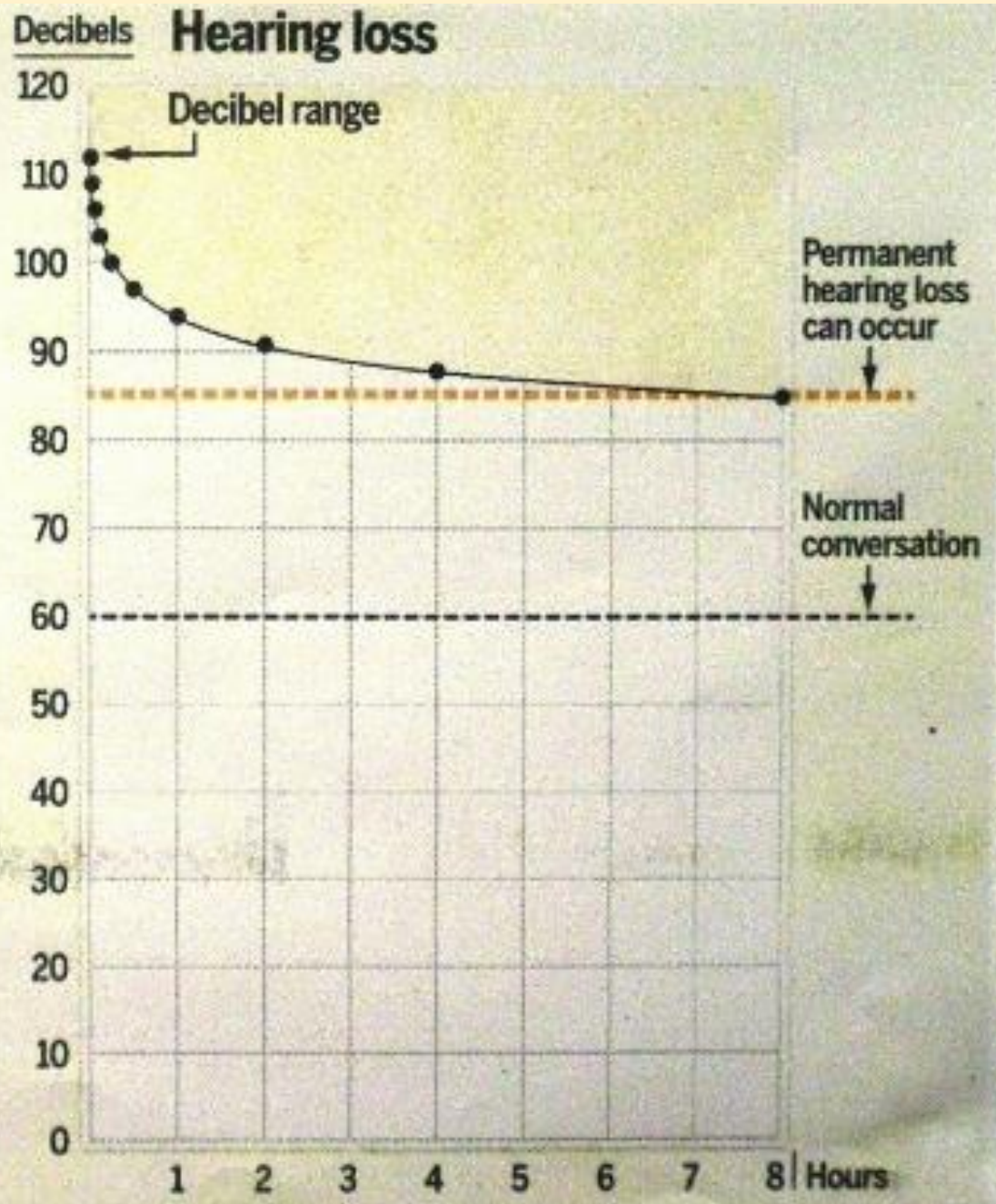
Farmers at risk

Farmers have a high rate of hearing loss because many of the activities involved in agriculture are loud. Continued exposure to 85 decibels or more is considered hazardous.

Noise levels *(in decibels)*

Each increase of 6 decibels doubles the noise level

Jet airplane	**140**
Pig squeals	**130**
Chain saw	**115**
Loud rock music	**115**
Chickens (inside building)	**105**
Garden tractor	**92**
Tractor wearing hearing protection devices	**85-95**
Lawn mower	**85**
Quiet whisper	**20**



Source: U.S. Department of Health and Human Services

Journal Sentinel

3 Horns at 25 feet can produce

122 dB for 3 Seconds

Too Loud

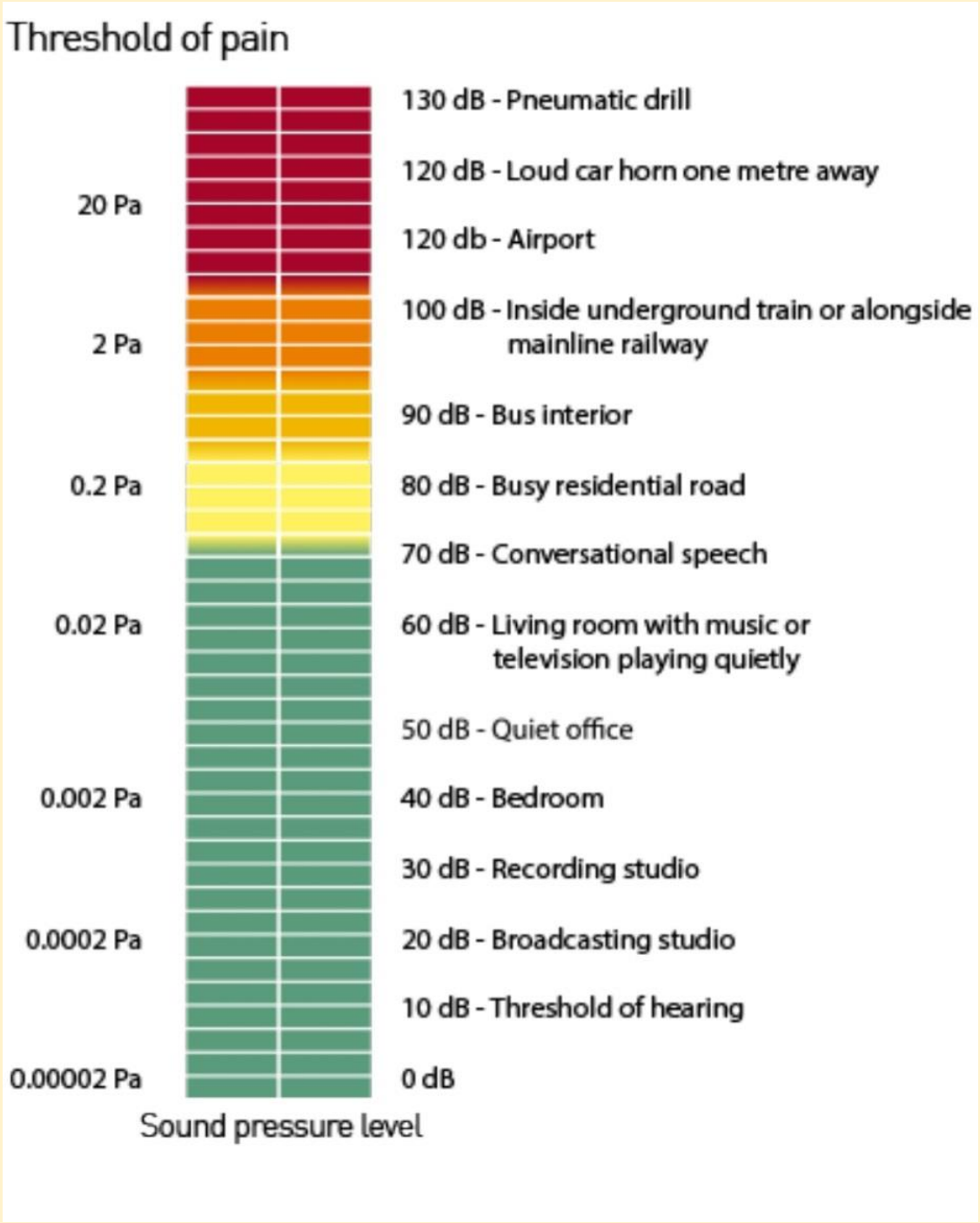
80 dBA@4’

My Suggested Diesel Horn range is:

60 dBA@__’

72 dBA@__’

@2’ , 4’ or 8’



My Diesel Horn

All the display data:

44.9 dBA Ambient (Slow)

My Horn Measured:

56 dBA@8’

62 dBA@4’

68 dBA@2’

(3 Sec. Continuous)

Your Diesel Horn

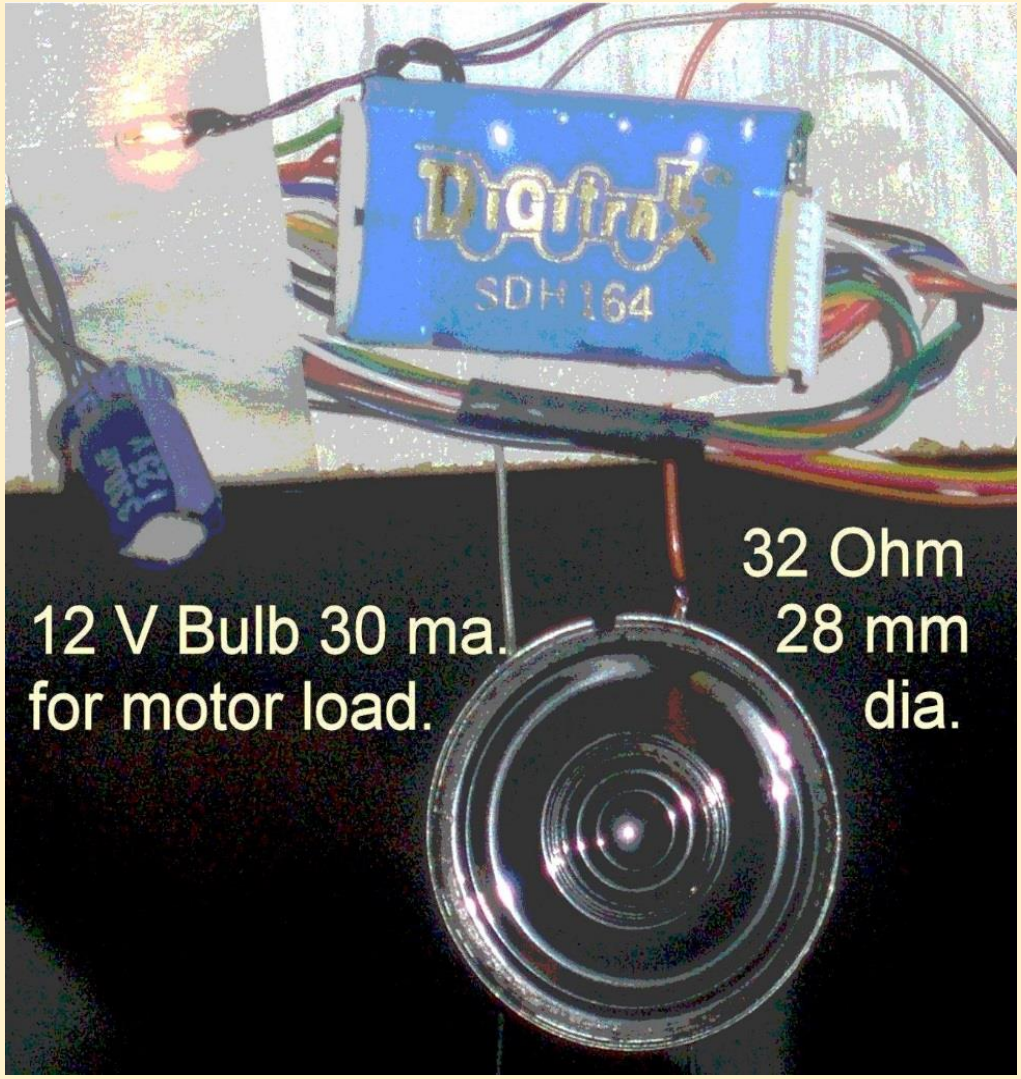
Distance from Sound?

Sound Level Meter Data

Digitrax SDH164D Diesel Horn

CV60=1(Diesel)

Master Volume	
CV58	**dB$_A$@4'**
15	64
12	62
9	60

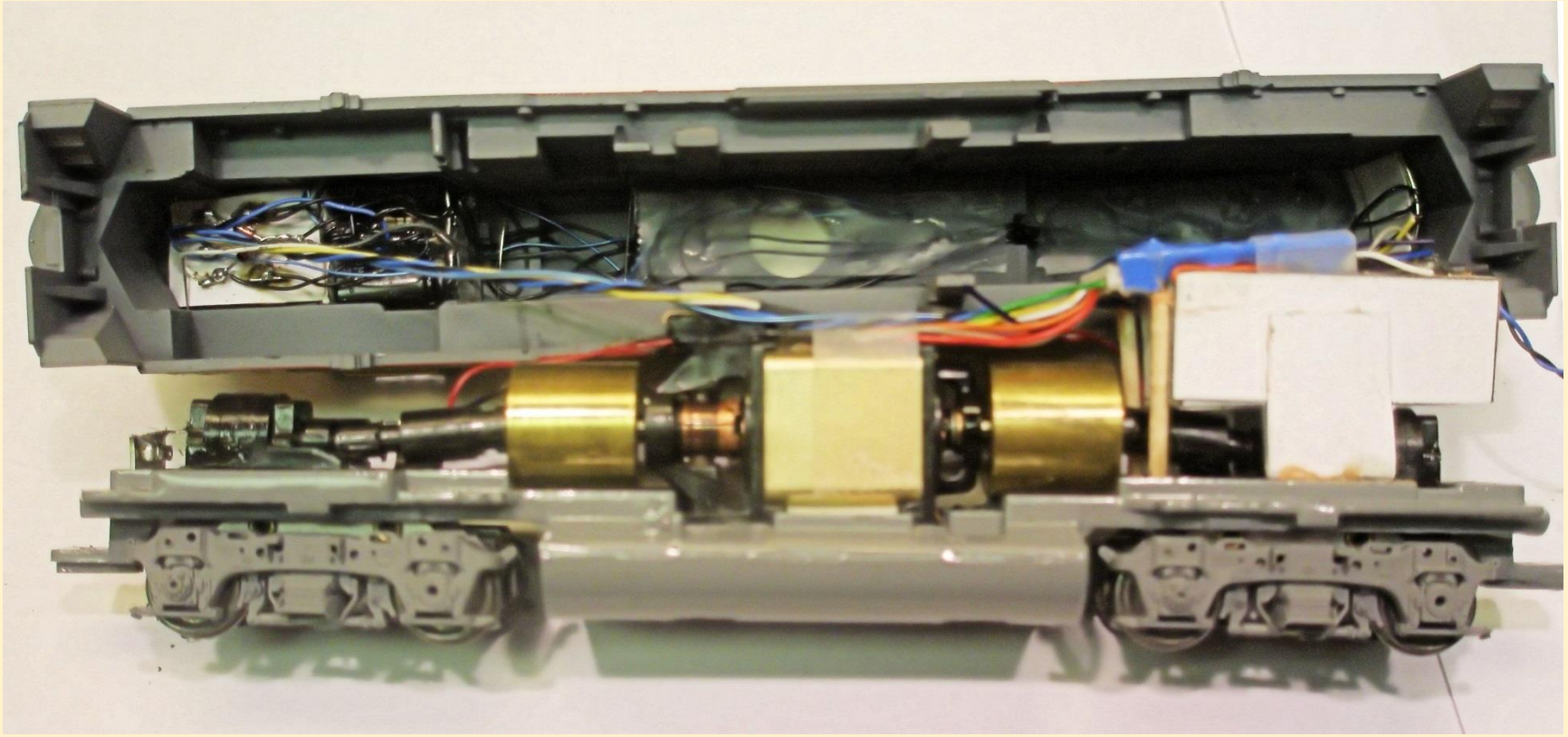


Digitrax SDH166D Diesel Horn

CV60=1(Diesel)

Master Volume	
CV58	**dBA@4'**
15	61
12	59
9	57

The Sound Source can be your finished Project



I Like my horn around 64 dBA@4’

QUESTIONS ?

Measure your diesel horn

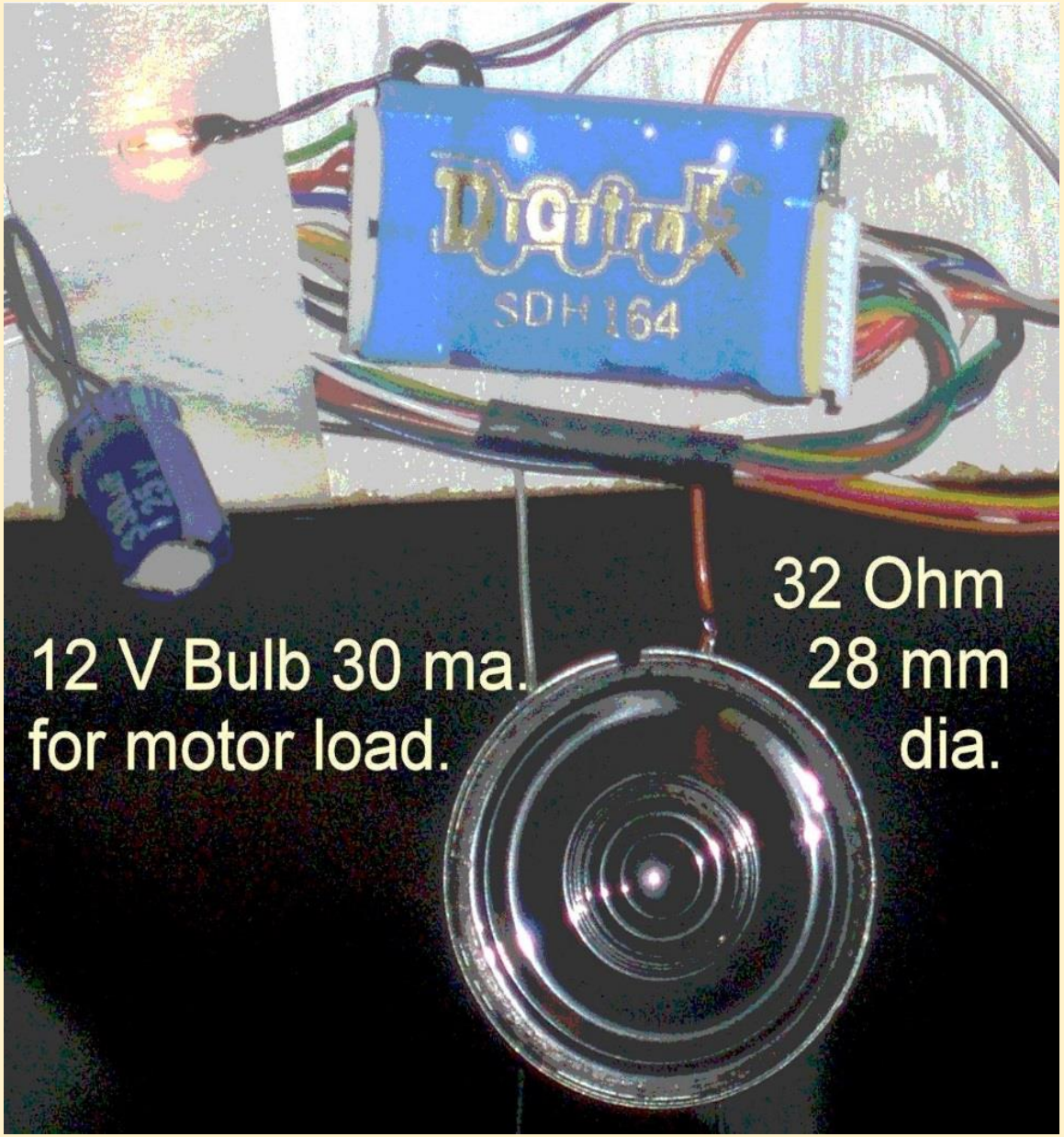
Part 2B:

Measuring the true (RMS) voltage driven by a DCC Sound Decoder into a speaker system of 4, 8, 16, or 32 ohms. Some examples of my measured Horns

2015 NMRA Convention By Robert Frey

Digitrax SDH164D Diesel Horn

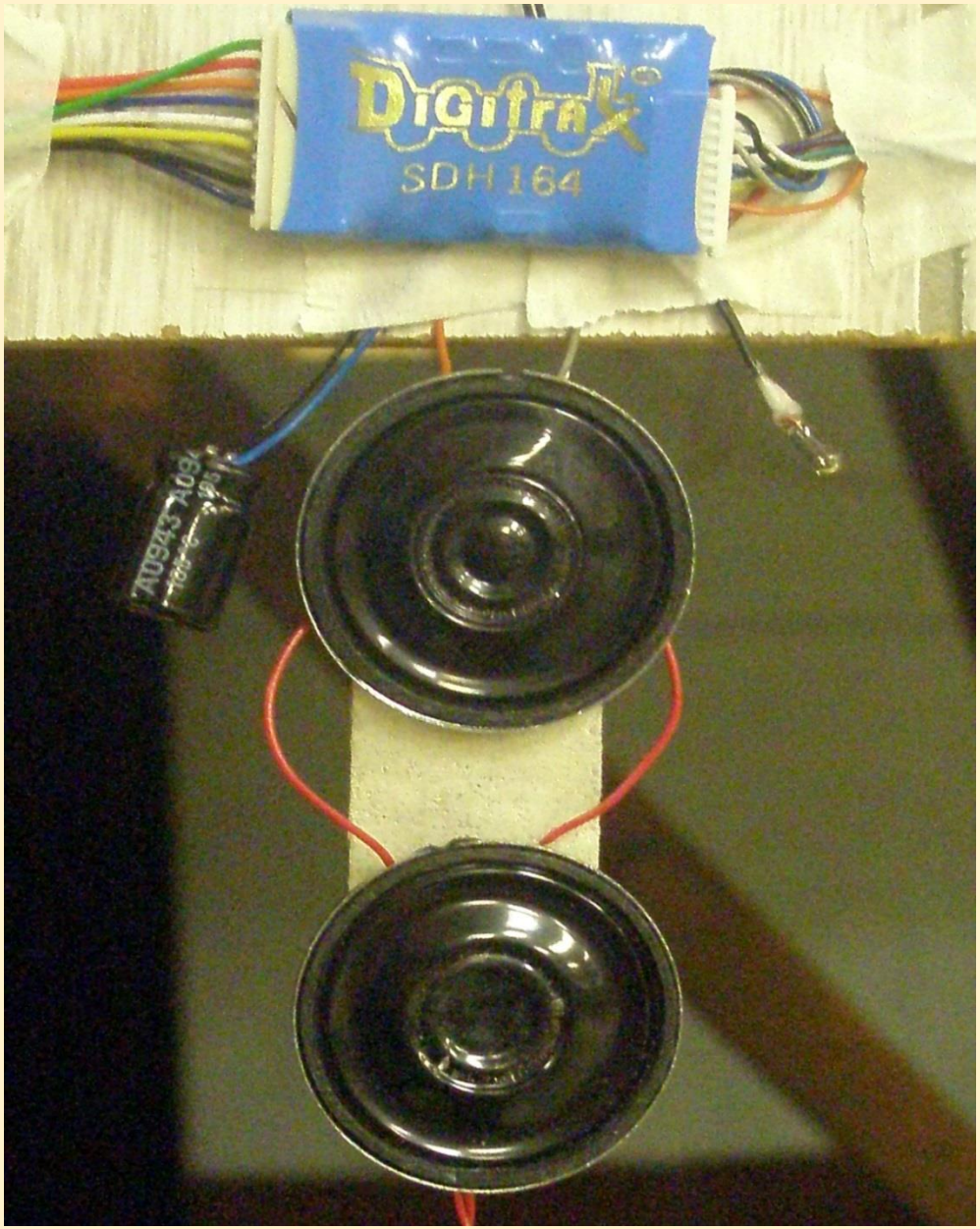
CV58	dBA@4'	**V**p-p
Idle	**41**	1.00
9	**60**	7.85
12	**62**	8.45
15	**64**	8.60
Vr/**V**p	52%	66%
CV58	**V**rms	Watts
Idle	0.21	0.00
9	2.05	0.13
12	2.51	0.20
15	2.85	0.25



Digitrax SDH164D Diesel Horn

16 Ohm

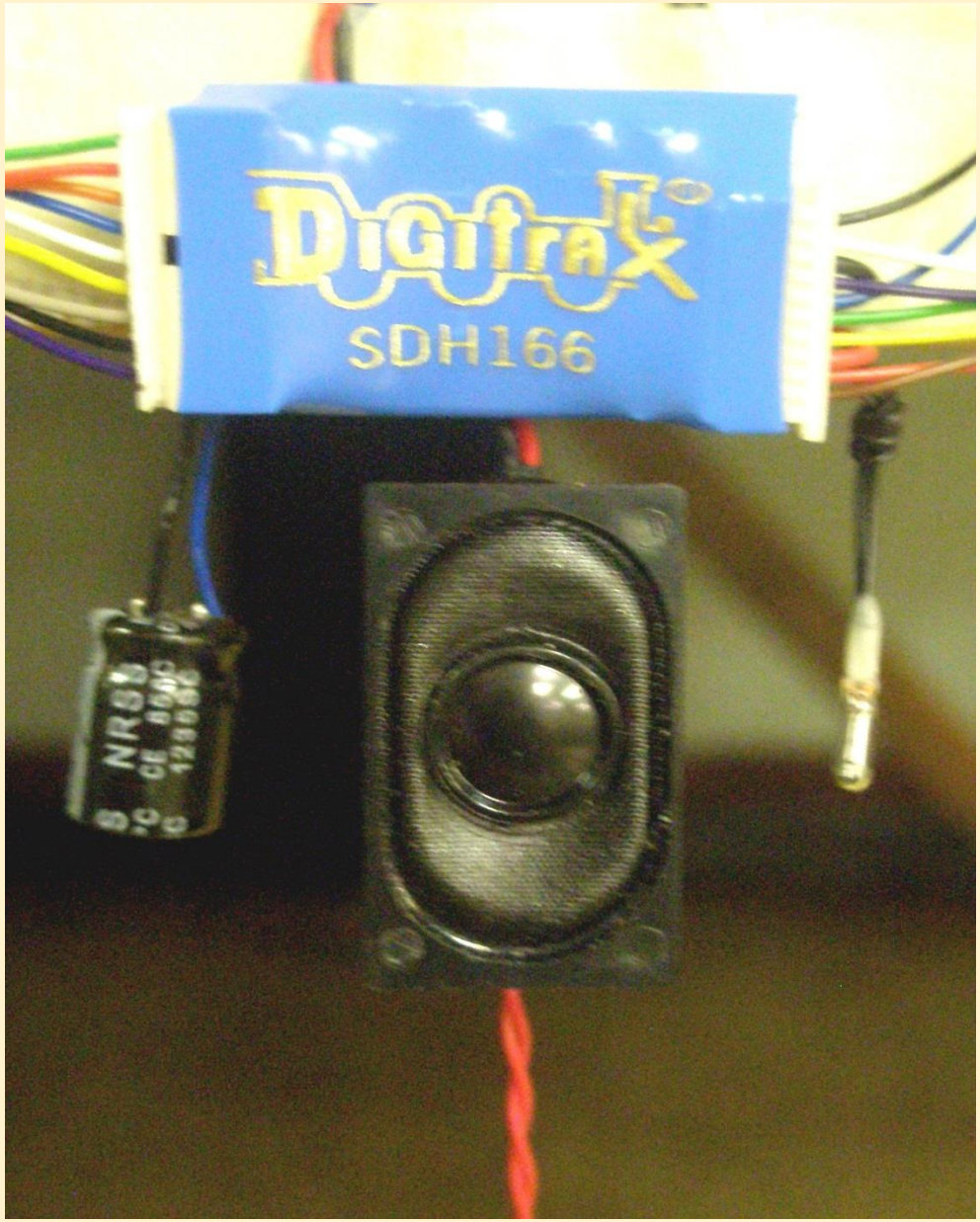
CV58	**dB**A@4'	**V**p-p
Idle	**44**	1.05
9	**63**	7.90
12	**65**	8.20
15	**67**	8.50
Vr/**V**p	52%	67%
CV58	**V**rms	Watts
Idle	0.22	0.00
9	2.04	0.26
12	2.50	0.39
15	2.85	0.51



Digitrax SDH166D Diesel Horn

8 Ohm

CV58	dBA@4'	Vp-p
Idle	**42**	0.40
9	**59**	3.60
12	**61**	4.95
15	**64**	5.60
Vr/Vp	47%	57%
CV58	**V**rms	Watts
Idle	0.10	0.00
9	0.84	0.09
12	1.16	0.17
15	1.53	0.29

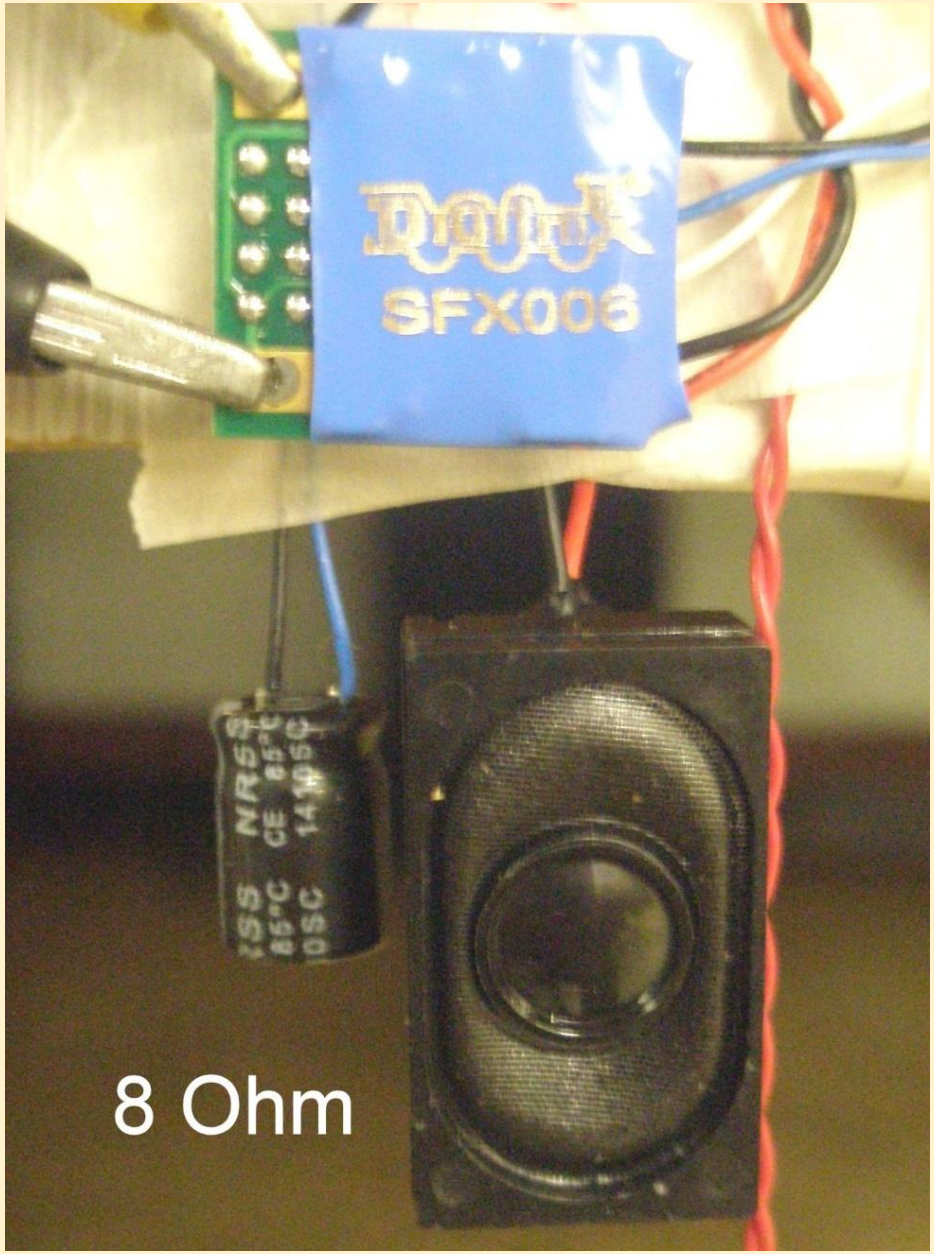


Digitrax SDH166D Diesel Horn **4** Ohm

CV58	**dB**A@4'	Vp-p
Idle	**44**	0.40
9	**63**	3.70
12	**66**	4.25
15	**68**	4.60
H+Run	**68**	4.70
Vr/**V**p	45%	68%
CV58	Vrms	Watts
Idle	0.10	0.00
9	0.83	0.17
12	1.13	0.32
15	1.40	0.49
H+Run	1.60	0.64

Digitrax SFX006 Soundbug Diesel Horn

CV58	**dB**A@4'	Vp-p
Idle	**42**	0.50
9	**61**	3.95
12	**63**	4.95
15	**66**	5.55
H+Run	**67**	5.60
Vr/Vp	47%	63%
CV58	Vrms	Watts
Idle	0.15	0.00
9	0.92	0.11
12	1.20	0.18
15	1.58	0.32
H+Run	1.75	0.38

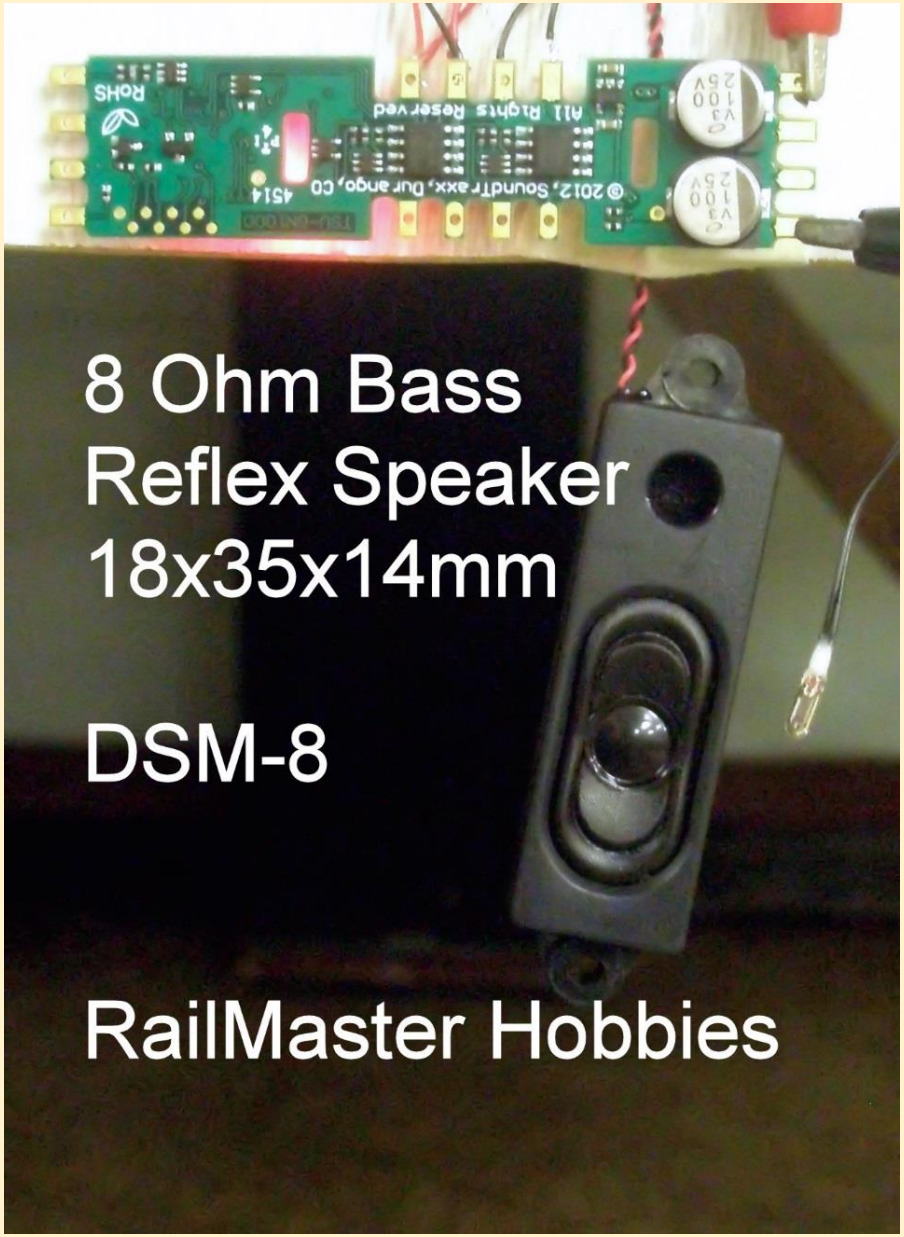


Digitrax SFX006 Soundbug Diesel Horn **4** Ohms

CV58	**dB**A@4'	Vp-p
Idle	**46**	0.60
9	**67**	3.45
12	**70**	4.50
15	**72**	4.60
H+Run	**72**	4.65
Vr/Vp	50%	68%
CV58	Vrms	Watts
Idle	0.27	0.02
9	0.86	0.19
12	1.21	0.37
15	1.44	0.52
H+Run	1.56	0.61

Tsunami by Soundtrax EMD 567

CV128	**dB**A@4'	Vp-p
Idle	**52**	2.40
192	**69**	4.45
228	**70**	5.05
254	**72**	5.30
H+Run	**73**	5.55
Vr/Vp	41%	47%
CV128	Vrms	Watts
Idle	0.54	0.04
192	0.91	0.11
228	1.05	0.14
254	1.16	0.15
H+Run	1.31	0.21



Measure your diesel horn

Tsunami EMD 567 WWW.soundtraxx.com
CV 128 = 228 then 1.05 Vrms is on the 8 ohm Speaker 18x53x14mm, DSM-9 where F2 Horn produced 70 dB Max. at 4’ with 0.14 Watts

Digitrax SDH166D CV 58 = 15 then 1.53 Vrms is on a 8 ohm Speaker 16x26x9mm, Box Speaker where F2 Horn produced 64 dB at 4’ with 0.29 Watts.

Conclusions

- We can all calculate Watts. Never burn out your sound amplifier again.
- All amplifiers have a max. V_p limit. When clipping gets really bad, then we all can finally hear it.
- It is hard to keep the total of 4 Voices from clipping off of the tops of your sound wave.
- Keep your Idles low. Four Diesels Idling In the Yard adds 12 **dB** of noise.

Digitrax Sound group We are learning about, working with, creating, editing, and installing sound files on Digitrax Sound decoders. (A finished spj sound file can be submitted to Digitrax.)

THE END

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