Report

The electrical signal in e-collars

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Why e-collars and what is this test about ?

E-collars can be a very valuable tool in dog training and even in dog rehabilitation. This report is not about how you need to train with e-collars but mainly about the electrical signal they produce, how that signal looks like, the quality of it and a comparison between some e-collar brands. This test is done by myself and an electronics engineer.

For who is this test ?

I made this test because I miss some information in the current documentation (I don't find any detailed papers about the electrical signal), also because I want to make a comparison between e-collars and for myself to learn more about the e-collar signal. Since some people I know are also interested in the results of this test, they are free to read it spread it in its entirety but not to change it in any way. There is a possibility that there are faults in my tests and/or my explanation, so I don't take any responsibilities about its content and/or the results of this report since it is meant for my own use. You can read it and interpret it anyway you want. If manufacturers read this document and see that there are faults in my tests or explanation, they are free to correct and inform me and I might add their notes and information to this report. It is also possible that -in a newer version of the document - I will change the content like additional explanation of the topic but I will not change the measuring results unless I do a new measuring test.

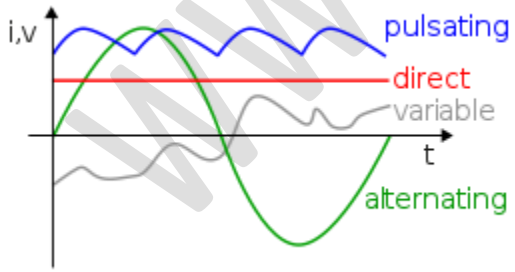
What kind of technology is used in e-collars ?

There are different e-collar manufacturers so there are different technologies too. Yes, they all produce an electrical signal but the shape of that electrical signal differs from brand to brand and another shape can mean another feeling for the dog (also depending of other factors). Some manufacturers invented and patented a good product with good technology but with a higher production cost and others may use another - maybe less sophisticated- technology with a lower production cost and another target audience. You can compare it with cars. You have cheap and expensive cars, all of them drive you from point A to point B but it's the way how you drive the car that makes you a good or a bad driver. I also wanted to check what the manufacturers say about their products is reflecting the reality.
For example, E-collar technologies use "blunt stimulation" and "AC" (alternating current) as a selling point. "Blunt stimulation" is a patented technology and it should be a better signal, you can compare it with the signal of a muscle stimulator and Dogtra vendor told me the same. So E-collar technologies, and others also use AC (alternating current). AC is (according to Wikipedia) widely used in e-collars and other brands have their own selling points too. For example, Martin System manufacturer says that their e-collar continuously measures the resistance between the 2 pins and that the signal changes (lower/higher values) according to this resistance (S.S.C. patent). Every manufacturer has selling points which can vary from the design, the technology etc. just like other products.

Alternating current (AC) or direct current (DC)?

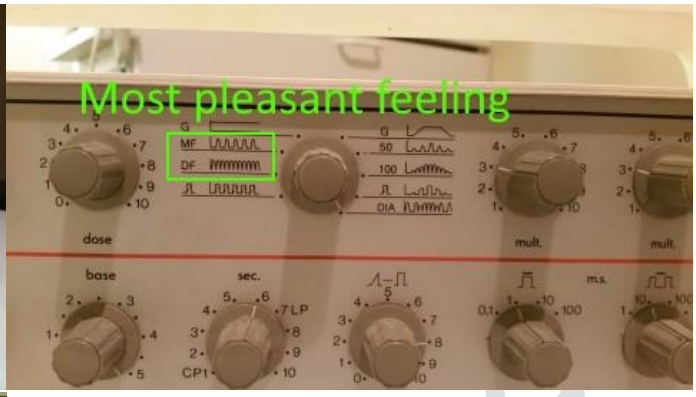
According to Wikipedia about alternating current:
The usual waveform of alternating current in most electric power circuits is a sine wave. In certain applications, different waveforms are used, such as triangular or square waves. Audio and radio signals carried on electrical wires are also examples of alternating current. These types of alternating current carry information encoded (or modulated) onto the AC signal, such as sound (audio) or images (video). These currents typically alternate at higher frequencies than those used in power transmission.

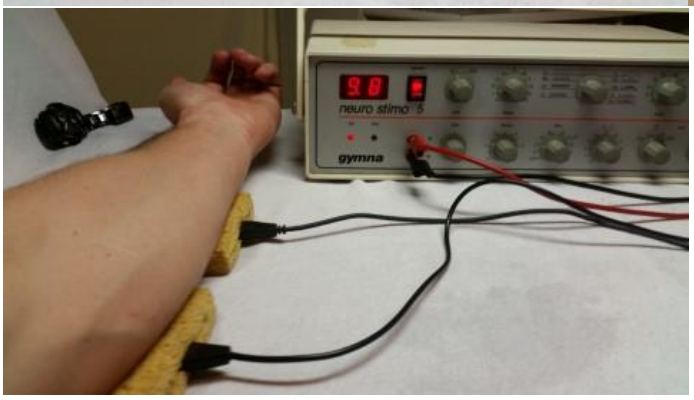
Look at the following picture, the green line is AC, anything else isn't. You can speak about AC when you have a repeating alternating signal with a polarity that changes and in the example below that signal is sinusoidal.



According to some manufacturers, alternating current is used in their e-collars. So why AC? A single DC signal (the red line on the image above) will make a single continuous contraction of the muscle and an AC signal (the green line in the image above) will make a series of contractions depending on the applied frequency. So AC should be better in e-collars because the muscle undergoes a series of contractions? Not exactly because you can also make a series of contractions with a pulsating DC (the blue line in the image above). I did a test with a professional muscle stimulator (the kind of equipment that is used for revalidation) and a few months ago I had to undergo an EMG (electromyogram) scan (that's a machine that measures the electrical activity of your muscles or the activity from the nerves that control the muscles). The most pleasant feeling was that of the pulsating DC on the muscle stimulator, it didn't hurt at all and it felt only like a contraction of the muscle. The EMG scan felt like a high, small peak. You can compare it with a pinprick.

Muscle stimulator machine, it's an older machine but it works fine.



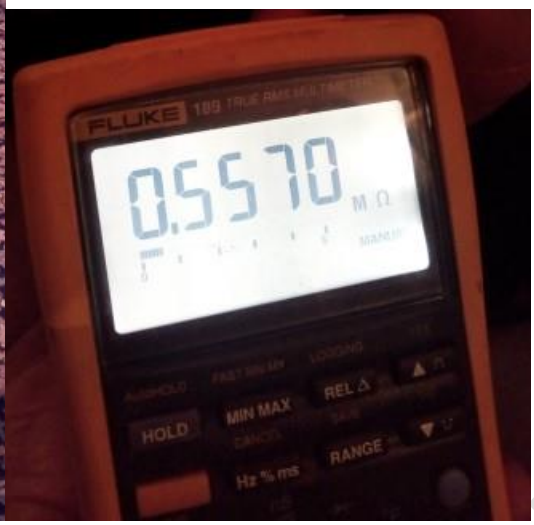


How is this test performed?

For this test I gathered some e-collars from some known e-collar brands and connected them to an oscilloscope and then we measured and analyzed the outcome and compared them with each other. We did this on single stim and on continuous stim. The e-collars that are used in this test are:

- Petsafe 1000
- Dogtra 620 NCP
- Garmin Delta Sport XC
- E-collar technologies pro educator ET-300
- E-collar technologies mini educator PE-900
- Martin Systems PT3000
- Martin Systems TT1000

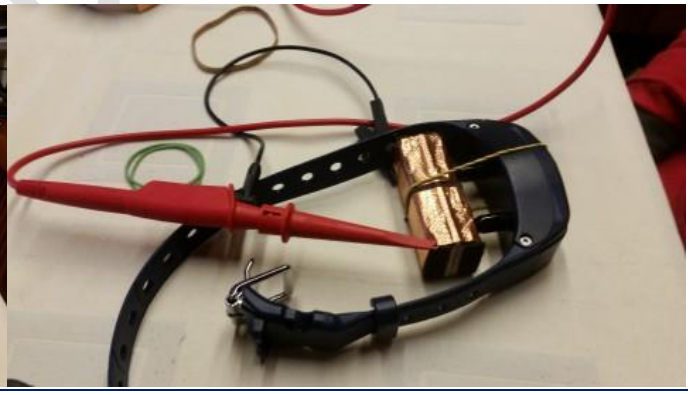
It is important to know that the internal resistance of the oscilloscope is **10 MΩ**, the resistance we measured on a dog (same distance as the e-collar pins) was **500 kΩ** (500 kilo Ohm is much less than 10 Mega Ohm) so the measured values in Volts that you will see on the "10MΩ" comparison graphs are not relevant (unless you have an e-collar that doesn't change its power with a different resistance). That is because the voltage goes up when the resistance is higher. That is interesting because your e-collar should notice a difference in the resistance and then apply a different voltage because. If this is not the case, you would always apply the highest voltage and that's not what you want to do. To keep consistencies, it is important we used the same resistance for all measurements (internal resistance from the oscilloscope) unless noted differently. **The comparison between the e-collars is relevant and valid and the shape of the amplitude should also be the same when using a lower resistance so that is also relevant**. The applied voltage on a real dog is lower because the resistance of a dog's skin is lower than the resistance of the oscilloscope. For example, the resistance on the dog (picture below) in this situation it was 500kΩ (inside the house and dry skin). The dog on the photo is just a dog that was available at that time we did the resistance measurement. This dog is not even an e-collar trained dog. It is important to know that the resistance of the skin can change and can differ because of the environment temperature, dog temperature, water, dog's fur blocking the pins etc…



Setup

On the pictures below you can see the setup which is the following:

- Professional oscilloscopes
- E-collar
- Wooden dummy (that is the dog) with 2 metal plates separated from each other so that we can connect the probes
- Resistors (not visible but sometimes we added another resistance to see if the values or shape changed)



What do we want to measure?

For every e-collar in this test we want to measure:

1. How big is the voltage in the different levels so that we can use the values for a comparison chart?
2. Do we get the same voltage when we tap several times?
3. How does the amplitude look like and is it AC or DC?
4. Does the amplitude change with a different resistance (dog in water = lower resistance and could that influence the shape of the impulse?).
5. Does the amplitude/voltage remain stable when using continuous stim?
6. What is the timeframe in one impulse?

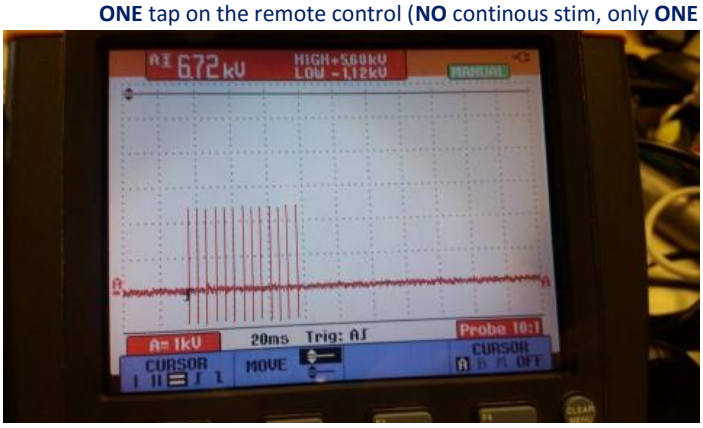
Test results

PETSAFE (8 levels of stimulation)

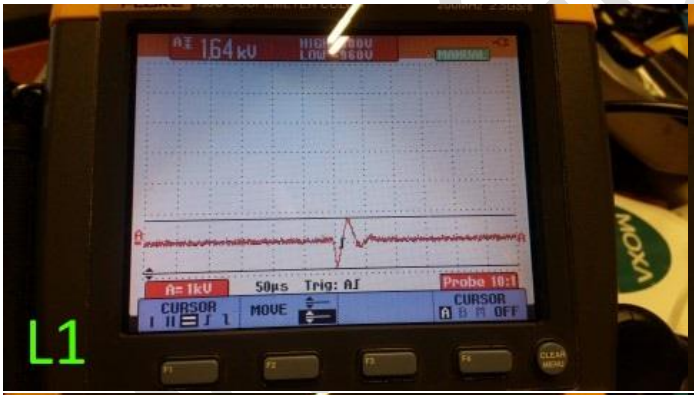
1. **How big is the voltage in the different levels so that we can use the values for a comparison chart?**
   Remember that the voltage values are not relevant in comparison with a dog because a dog has a much lower resistance than the internal resistance of the oscilloscope.

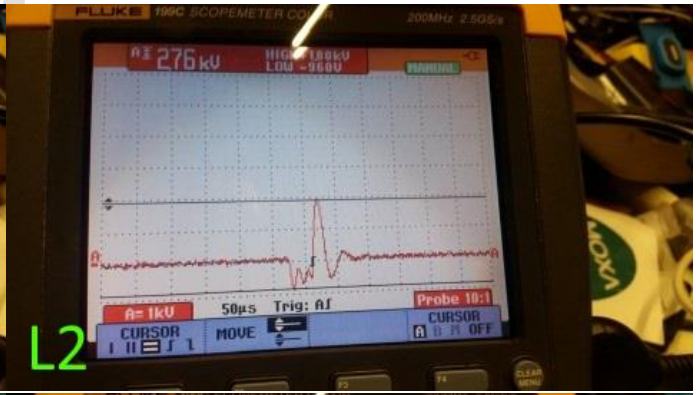
number of available levels	L1	L2	L3	L4	L5	L6	L7	L8
Petsafe (only 8 levels)	1600	2700	3200	4200	5000	5500	6000	6700

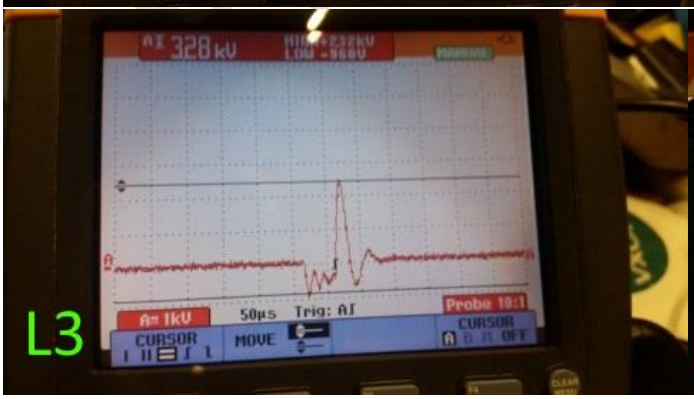
2. **Do we get the same voltage when we tap several times at the same level?** – No, we could determine a small difference.
   The first time we tapped was a slightly lower amplitude than the next times we tapped at that same level.
3. **How does the amplitude look like and is it AC or DC?**
   ONE tap on the remote control (**NO** continous stim, only **ONE** tap) exists of 13 amplitudes so **ONE** tap on the button looks like this:

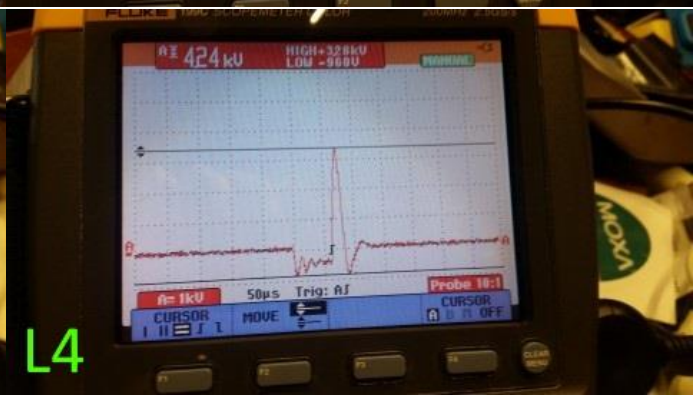


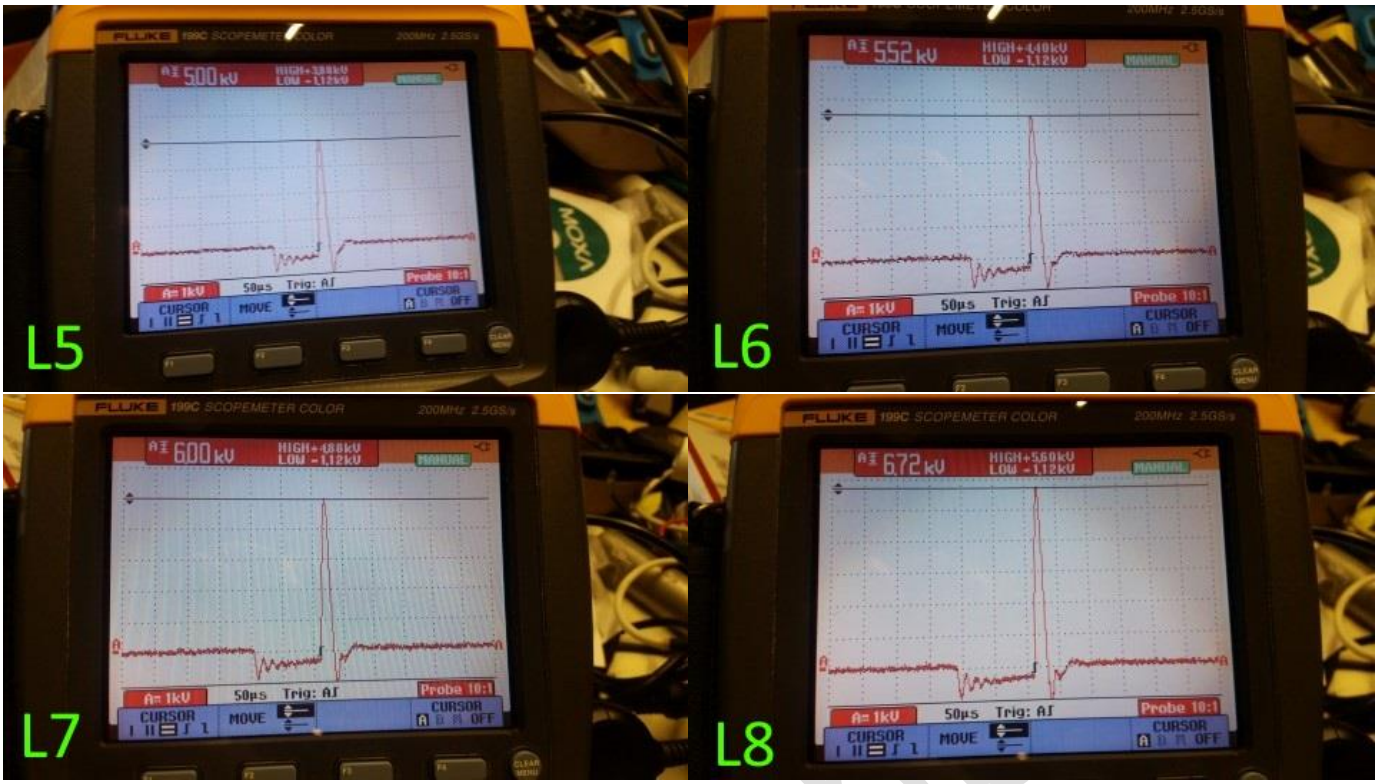
When we zoom in on that image and look at one single vertical line (example from the image above -Level 8 tap) then we can see how **ONE** amplitude looks like.
What you see on the images below is only **ONE** amplitude from the different levels and every single tap exists of 13 impulses, the shape of that amplitude is important.
Is that shape **AC** or **DC** ? Well, what we have is a periodic non-sinusoidal waveform, theoretically speaken you can say it is AC because it is repetitive and the polarity changes but it's not a nice smooth wave.
Smooth communication will not be possible with this e-collar because of the combination of the waveform, the limited levels and the strong power it generates.

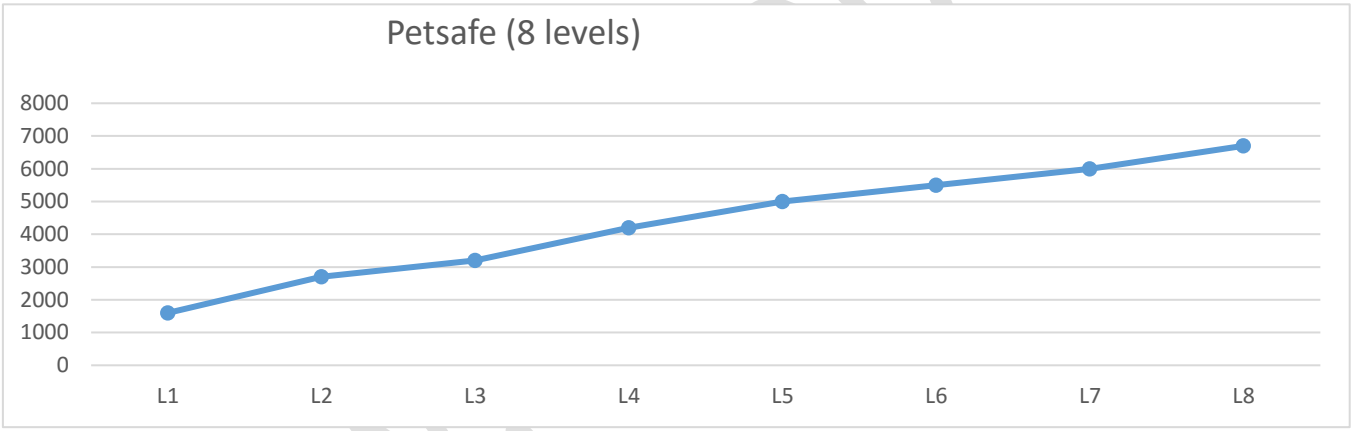




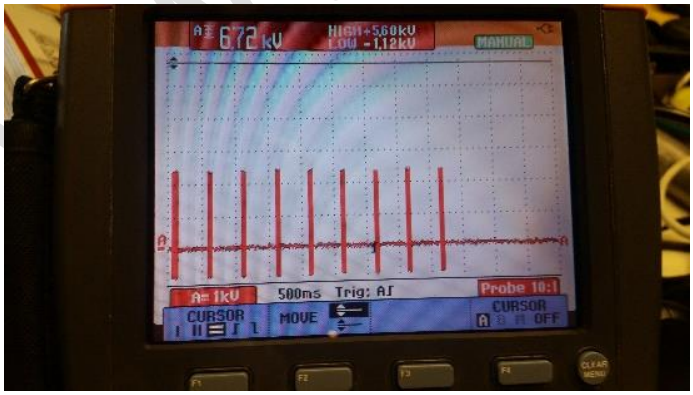








4. **Does the amplitude change with a different resistance (dog in water = lower resistance and can that influence the impulse)?**
   Only a very little bit, not worth mentioning
5. **Does the amplitude/voltage remain stable when using continuous stim?**
   Yes



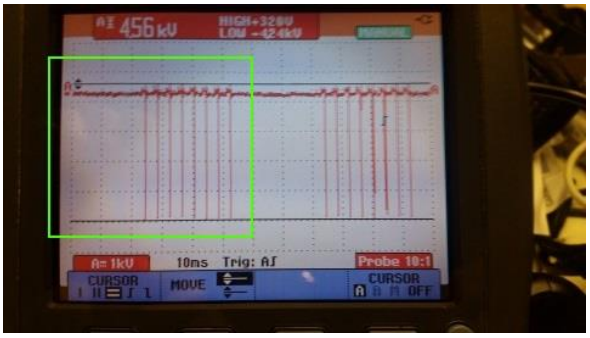
6. **What is the timeframe from one impulse?**
   As said before, 1 tap is 13 times the single impulse and the main impulse = 25 µsec. * 13
   The time between the peaks on constant stim is 50m. sec.

DOGTRA 620 NCP (127 levels of stimulation)

1. **How big is the voltage in the different levels so that we can use the values for a comparison chart?**
   Remember that the voltage values are not relevant in comparison with a dog because a dog has a much lower resistance than the internal resistance of the oscilloscope.

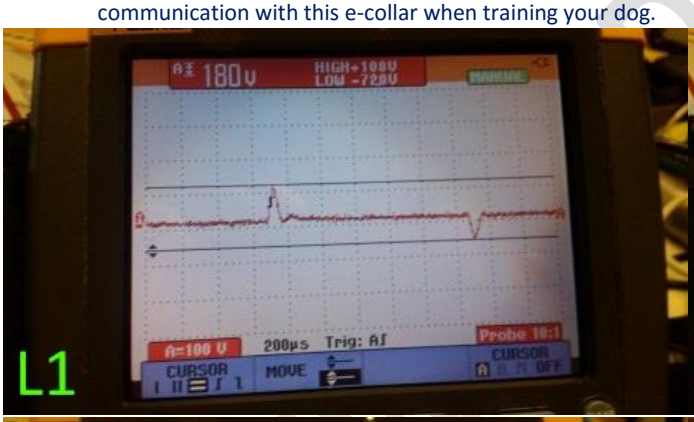
level	L1	L8	L16	L24	L32	L40	L48	L56	L64	L72	L80	L88	L96	L104	L112	L120	L127
Dogtra	170	340	512	700	860	1000	1300	1700	2000	2320	2700	3000	3700	4360	4560	4560	4560

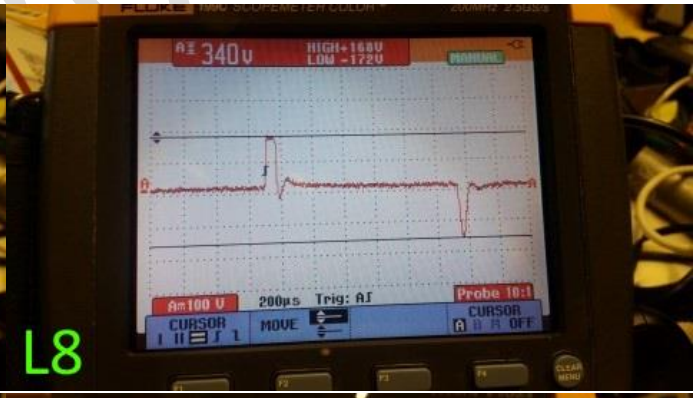
2. **Do we get the same voltage when we tap several times on a same level?** – Yes, stable
3. **How does the amplitude look like and is it AC or DC?**
   ONE tap on the remote control (**NO** continous stim, only **ONE** tap) exists of 8 impulses, compared with the Petsafe e-collar who has 13 amplitutes (this doesn't mean that it is better or worse) so one tap on the button looks like this (inside the green square):

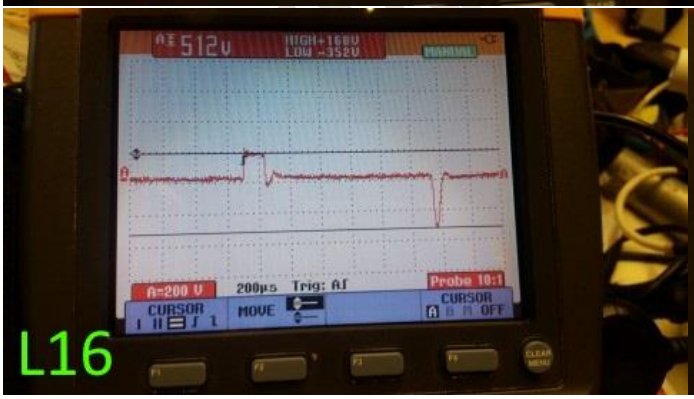


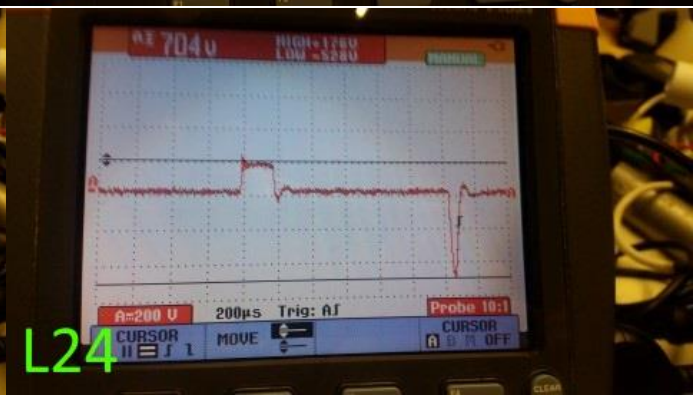
When we zoom in on that image and look at one single vertical line then we can see how **ONE** amplitude looks like (images below). Is that shape **AC** or **DC** ?

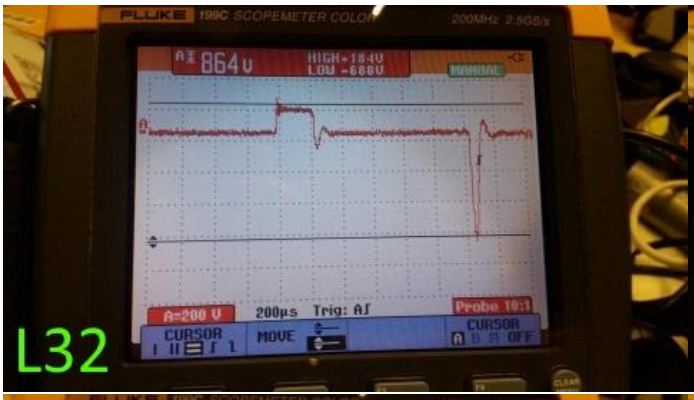
Again, we have a periodic non-sinusoidal waveform, theoretically speaken you can say it is AC because it is repetitive and the polarity changes but it's not a nice smooth wave. With this Dogtra e-collar you can see that –on the most levels- in one impulse you get a flat wave and a peak. In my experience, the peak you see is the pinprick you feel when you test the e-collar on yourself at a higher level. I don't consider this as a problem because of the 127 levels this e-collar has so I do believe that you can establish smooth communication with this e-collar when training your dog.

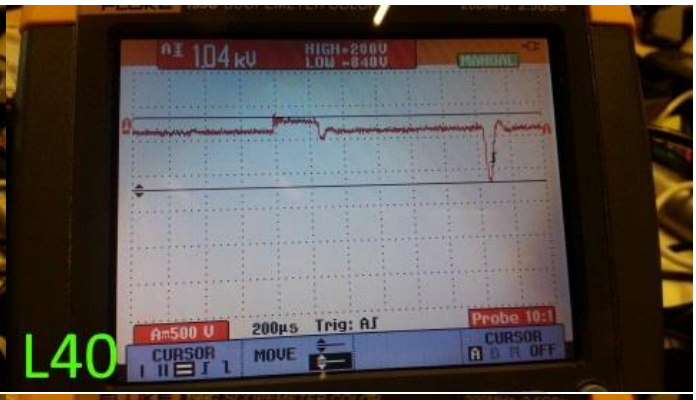


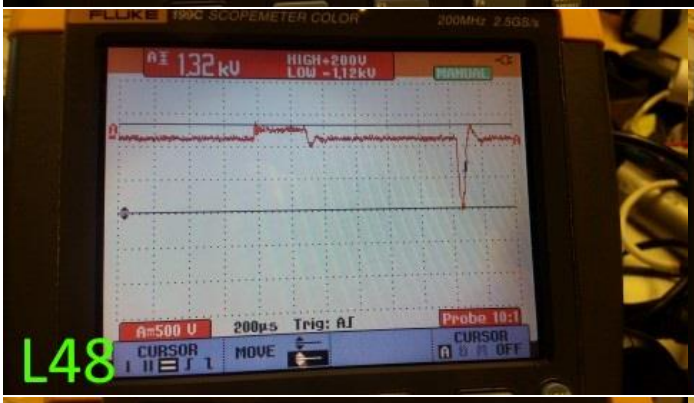


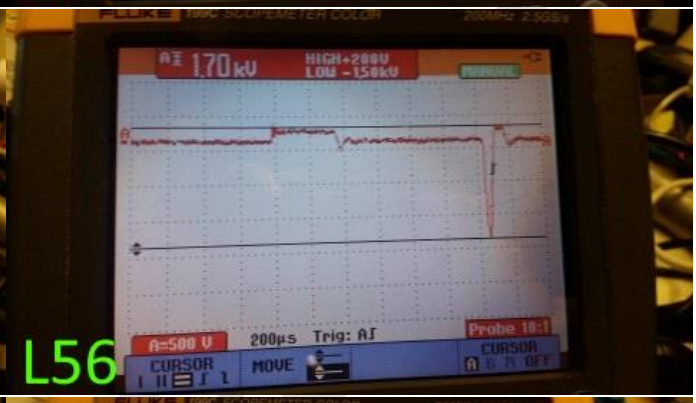


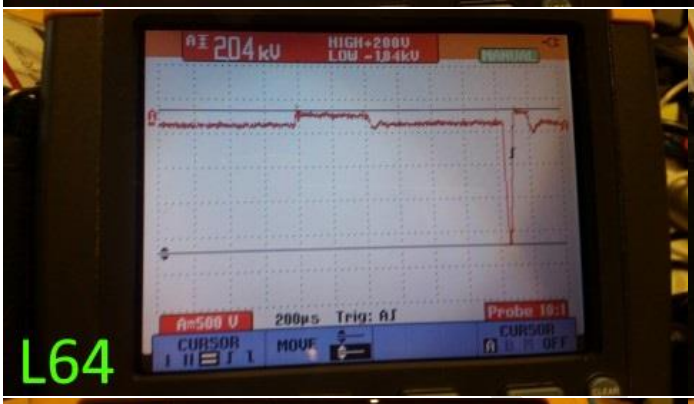


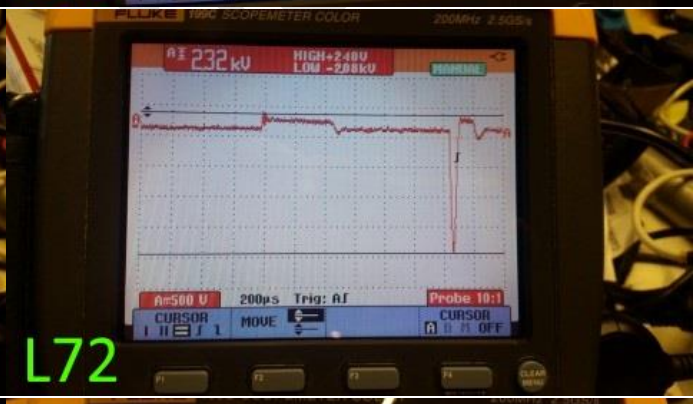

L32
FLUKE 199C SCOPEMETER COLOR
200MHz 2.5GS/s
A 864 V
HIGH +184V
LOW -688V
MANUAL
A=200 V
200µs Trig: AΓ
Probe 10:1
CURSOR
MOVE
CURSOR
OFF


L40
A 1.04 kV
HIGH +200V
LOW -840V
MANUAL
A=500 V
200µs Trig: AΓ
Probe 10:1
CURSOR
MOVE
CURSOR
OFF


L48
A 1.32 kV
HIGH +200V
LOW -1.12kV
MANUAL
A=500 V
200µs Trig: AΓ
Probe 10:1
CURSOR
MOVE
CURSOR
OFF

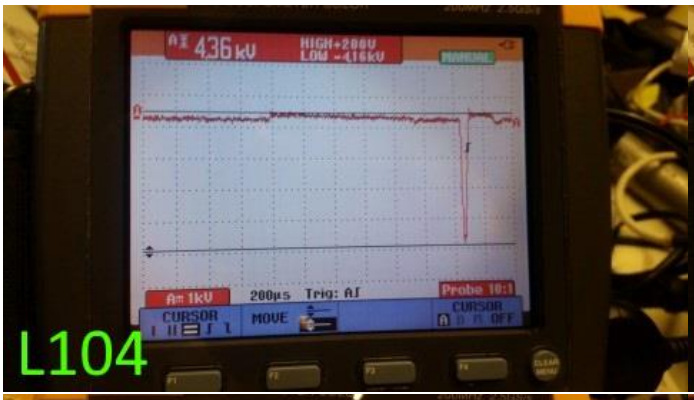

L56
A 1.70 kV
HIGH +200V
LOW -1.50kV
MANUAL
A=500 V
200µs Trig: AΓ
Probe 10:1
CURSOR
MOVE
CURSOR
OFF

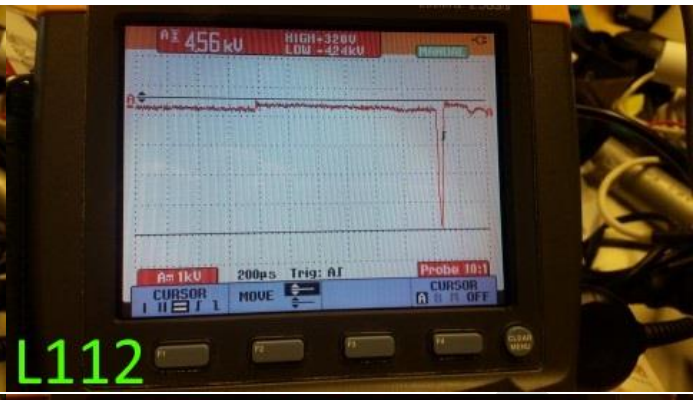

L64
A 204 kV
HIGH +200V
LOW -184kV
MANUAL
A=500 V
200µs Trig: AΓ
Probe 10:1
CURSOR
MOVE
CURSOR
OFF

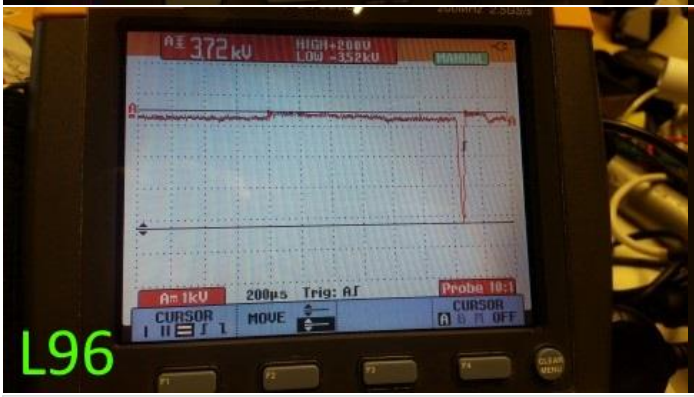

L72
A 232 kV
HIGH +240V
LOW -208kV
MANUAL
A=500 V
200µs Trig: AΓ
Probe 10:1
CURSOR
MOVE
CURSOR
OFF

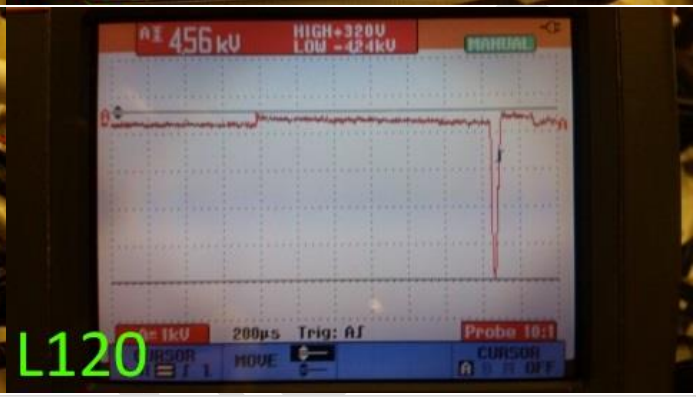

L80
A 270 kV
HIGH +280V
LOW -242kV
MANUAL
A=500 V
200µs Trig: AΓ
Probe 10:1
CURSOR
MOVE
CURSOR
OFF

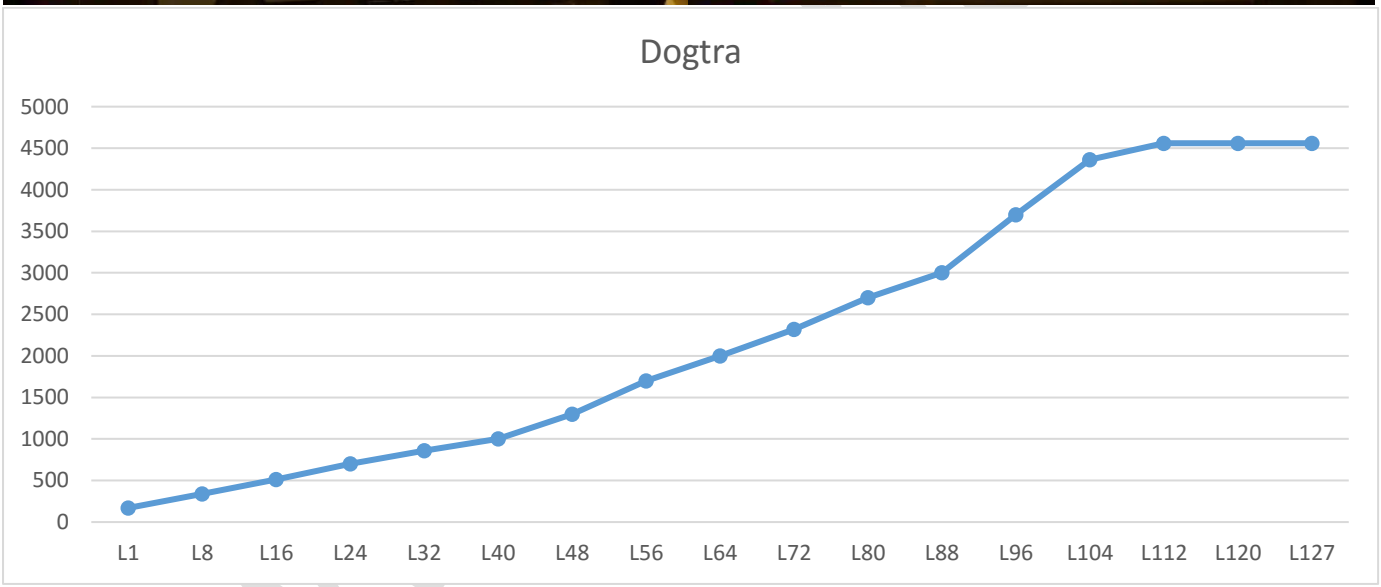

L88
A 304 kV
HIGH +200V
LOW -284kV
MANUAL
A= 1kV
200µs Trig: AΓ
Probe 10:1
CURSOR
MOVE
CURSOR
OFF



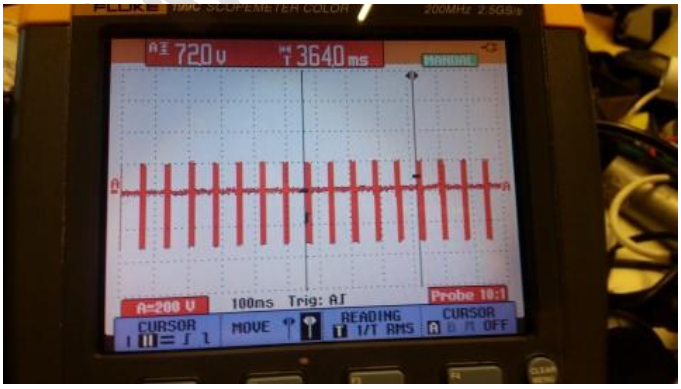








4. **Does the amplitude change with a different resistance (dog in water = lower resistance and can that influence the impulse)?**
   The amplitude stays the same with another resistance
5. **Does the amplitude/voltage remain stable when using continuous stim?**
   YES



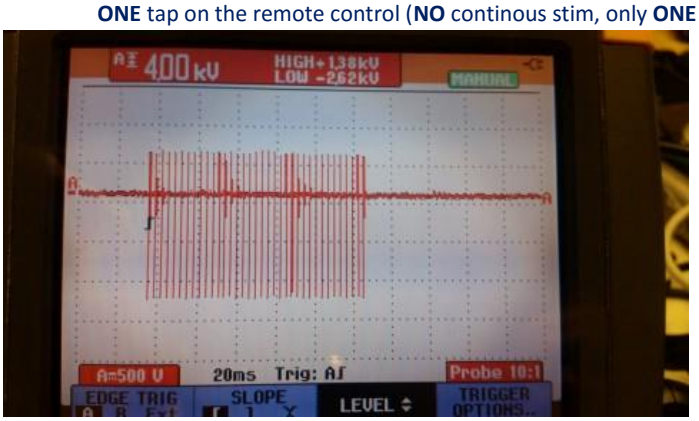
6. **What is the timeframe from one impulse?**
   1 tap = 8 times the single impulse and the main impulse = 75µsec. * 8
   The time between 2 peaks on constant stim is 75msec.

GARMIN DELTA SPORT XC (18 levels of stimulation)

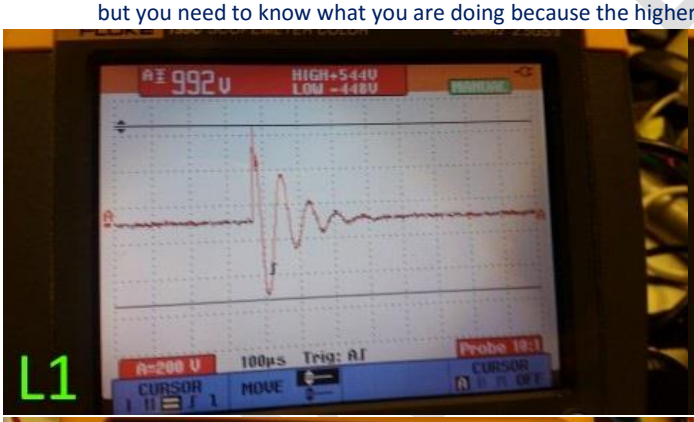
1. **How big is the voltage in the different levels so that we can use the values for a comparison chart?**
   Remember that the voltage values are not relevant in comparison with a dog because a dog has a much lower resistance than the internal resistance of the oscilloscope.
   Remark about LEVEL 18 value ➔ we couldn't measure that because it was too high for the fluke meter so it is more than 8000.

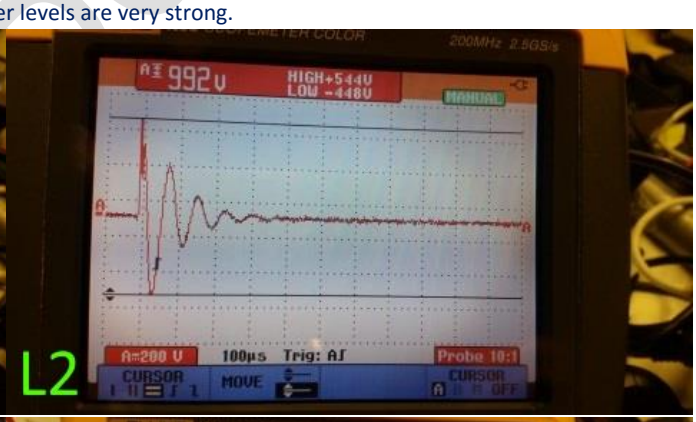
level	L1	L2	L3	L4	L5	L6	L7	L8	L9	L10	L11	L12	L13	L14	L15	L16	L17	L18
Garmin	992	992	1000	1100	1220	1360	1600	1880	2320	2760	3200	4200	5120	6000	6200	6640	8000	8000

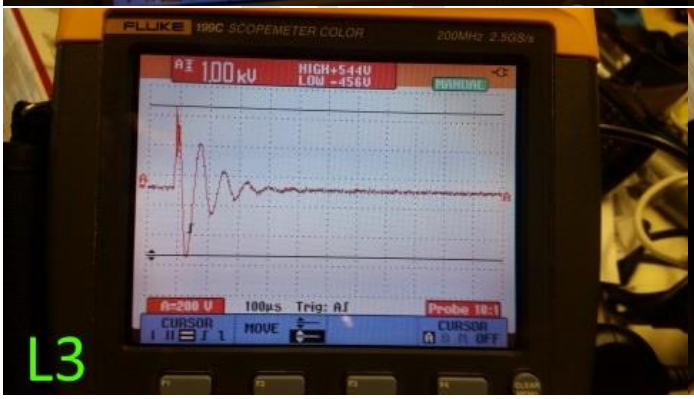
2. **Do we get the same voltage when we tap several times?** Yes, stable
3. **How does the amplitude look like and is it AC or DC?**
   ONE tap on the remote control (**NO** continous stim, only **ONE** tap) exists of a burst of 36 impulses.

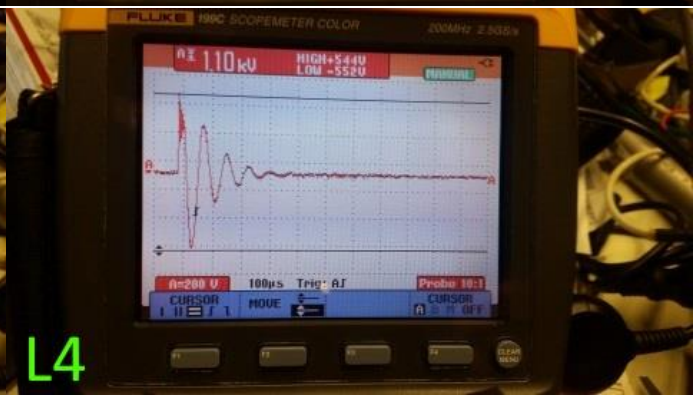


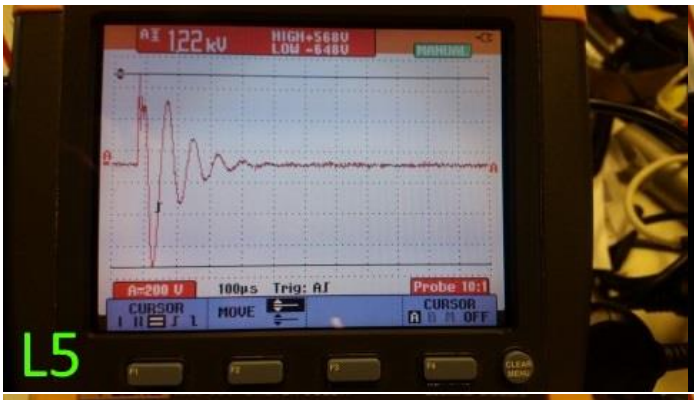
When we zoom in on that image and look at one single vertical line then we can see how **ONE** impulse looks like (images below).
Is that shape **AC** or **DC** ? The shape in the lower levels look like a sinusoidal waveform so yes we have alternating current but when the levels get higher, the shape changes and it's not a nice sine wave anymore so then it changes to a periodic non-sinusoidal waveform. Theoretically speaken you still can say it is AC because it is repetitive and the polarity changes but it's not a nice smooth wave. So with this Garmin e-collar you can see that on the lower levels you get AC without peaks but at higher levels you get the pinprick. With the combination of 18 levels, this kind of signal and the high power this e-collar can generate, you can work smoothly on the lower levels but you need to know what you are doing because the higher levels are very strong.



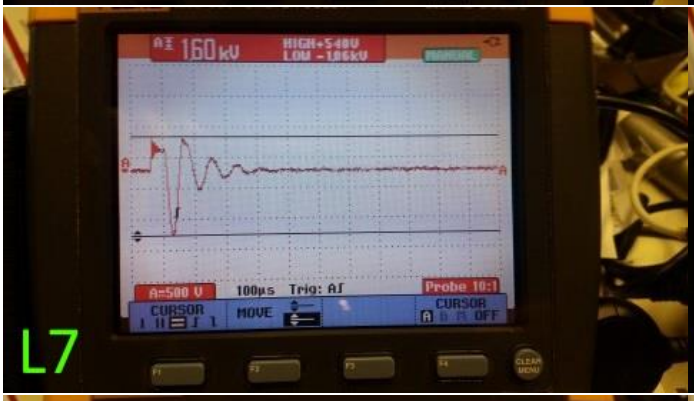


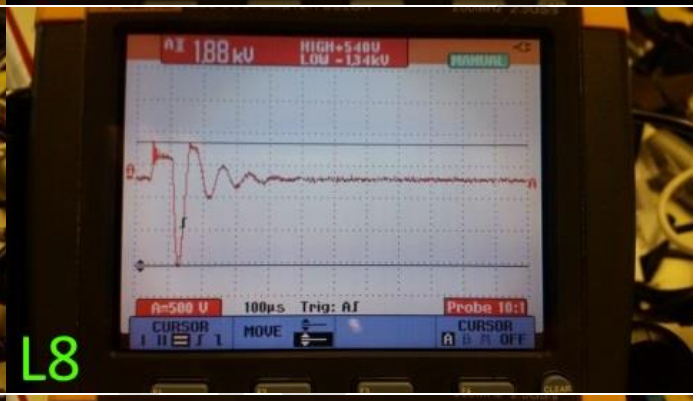


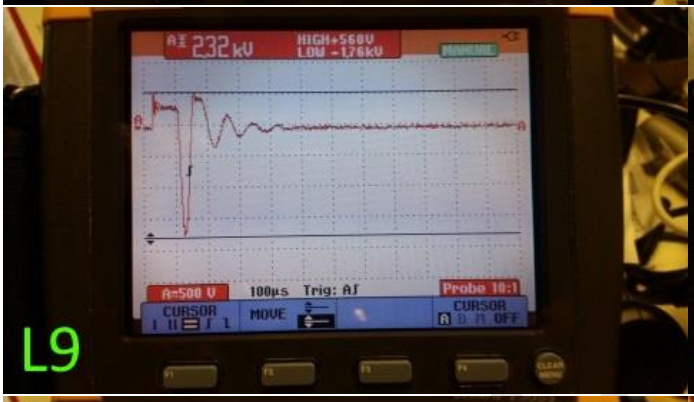


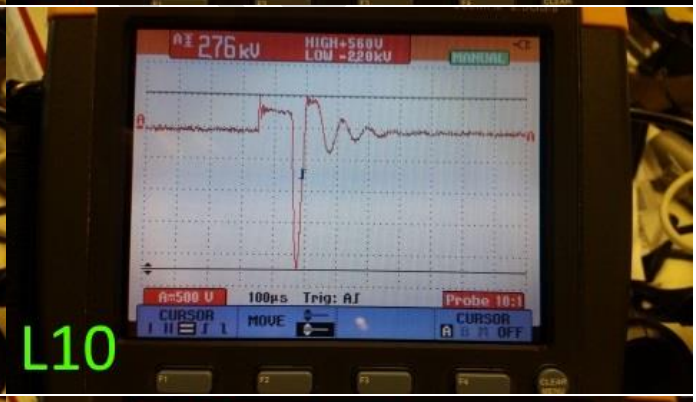

122 kV
HIGH+568V
LOW -648V
MANUAL
A=200 V
100µs Trig: AƒI
Probe 10:1
CURSOR
MOVE
CURSOR
OFF
L5

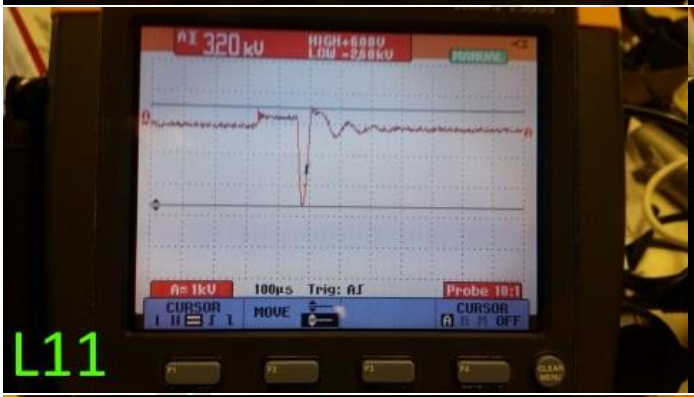

136 kV
HIGH+548V
LOW -820V
MANUAL
L6

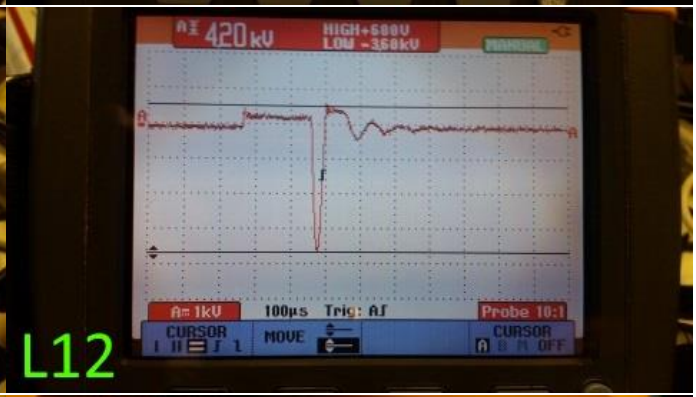

160 kV
HIGH+548V
LOW -1.06kV
MANUAL
A=500 V
100µs Trig: AƒI
Probe 10:1
CURSOR
MOVE
CURSOR
OFF
L7

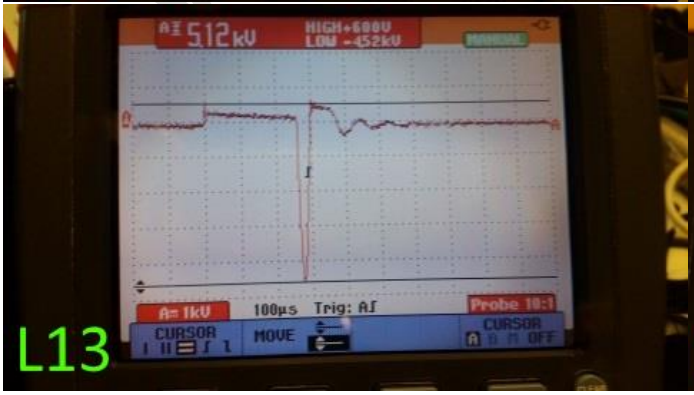

188 kV
HIGH+548V
LOW -1.34kV
MANUAL
A=500 V
100µs Trig: AƒI
Probe 10:1
CURSOR
MOVE
CURSOR
OFF
L8

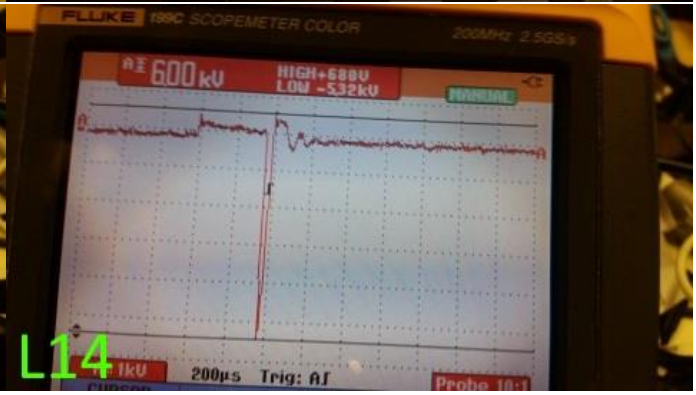

232 kV
HIGH+568V
LOW -1.76kV
MANUAL
A=500 V
100µs Trig: AƒI
Probe 10:1
CURSOR
MOVE
CURSOR
OFF
L9

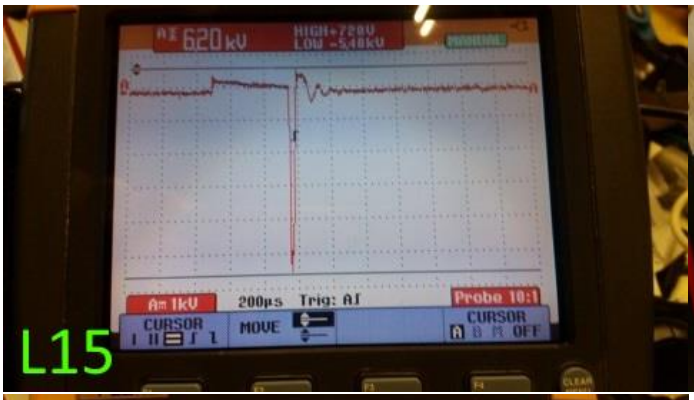

276 kV
HIGH+568V
LOW -220kV
MANUAL
A=500 V
100µs Trig: AƒI
Probe 10:1
CURSOR
MOVE
CURSOR
OFF
L10

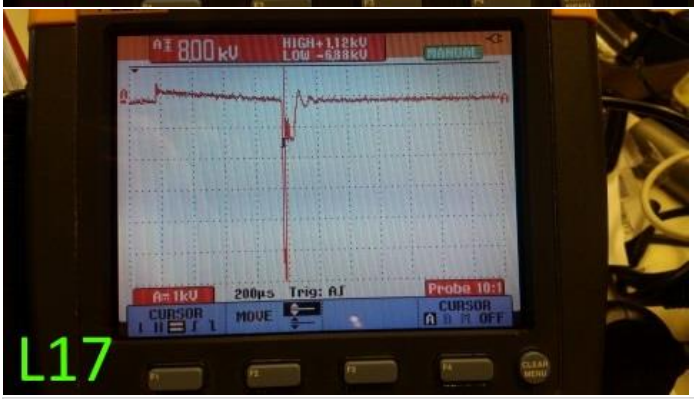

320 kV
HIGH+688V
LOW -248kV
MANUAL
A=1kV
100µs Trig: AƒI
Probe 10:1
CURSOR
MOVE
CURSOR
OFF
L11

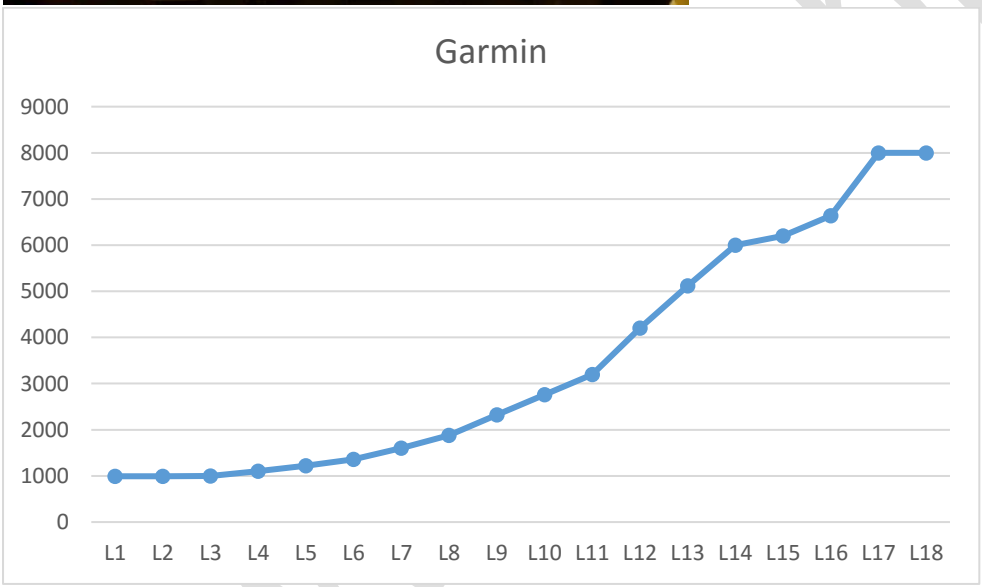

420 kV
HIGH+688V
LOW -368kV
MANUAL
A=1kV
100µs Trig: AƒI
Probe 10:1
CURSOR
MOVE
CURSOR
OFF
L12


512 kV
HIGH+688V
LOW -452kV
MANUAL
A=1kV
100µs Trig: AƒI
Probe 10:1
CURSOR
MOVE
CURSOR
OFF
L13


FLUKE 199C SCOPEMETER COLOR
200MHz 2.5GS/s
600 kV
HIGH+688V
LOW -532kV
MANUAL
1kV
200µs Trig: AƒI
Probe 10:1
L14







4. **Does the amplitude change with a different resistance (dog in water = lower resistance and can that influence the impulse)?**
   It stays the same
5. **Does the amplitude/voltage remain stable when using continuous stim?**
   Yes.
   Continuous stim is a burst of 3 impulses (3 * 36 single impulses) every 260msec.
6. **What is the timeframe from one single impulse?**
   1 tap = 36 * 64 µsec.
   The duration of the main impulse = 64 µsec.
   The time between the impulses in a tap is 3 msec.
   The time between the impulses on cont. stim is 64 msec.

E-COLLAR TECHNOLOGIES Pro Educator PE-900 (100 levels of stimulation)

1. **How big is the voltage in the different levels so that we can use the values for a comparison chart?**
   Remember that the voltage values are not relevant in comparison with a dog because a dog has a much lower resistance than the internal resistance of the oscilloscope.

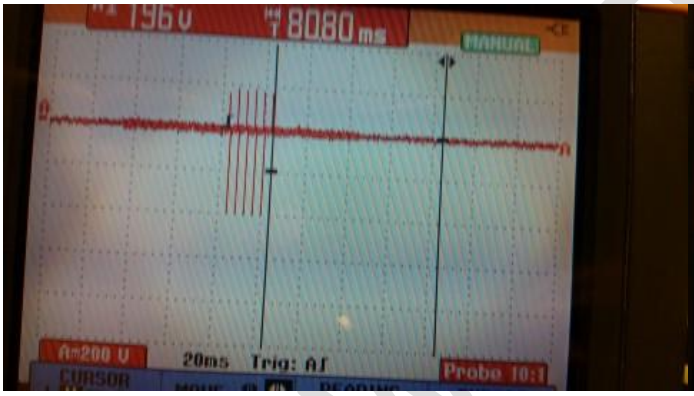
Levels	L1	L2	L5	L10	L15	L20	L25	L30	L35	L40	L45	L50	L55	L60	L65	L70	L75	L80	L85	L90	L95	L100
PE-900	0	72	312	556	776	1000	1220	1420	1620	1800	1920	2160	2340	2600	2860	3120	3560	3760	3960	4200	4560	4840

   For this e-collar, we made a separate measurement with a lower resistance too. We noticed that if there is less resistance, there is a lower voltage too (when the dog is in the water, you have a lower skin resistance).
   I don't know if the other e-collars behave in the same way, I hope they do.

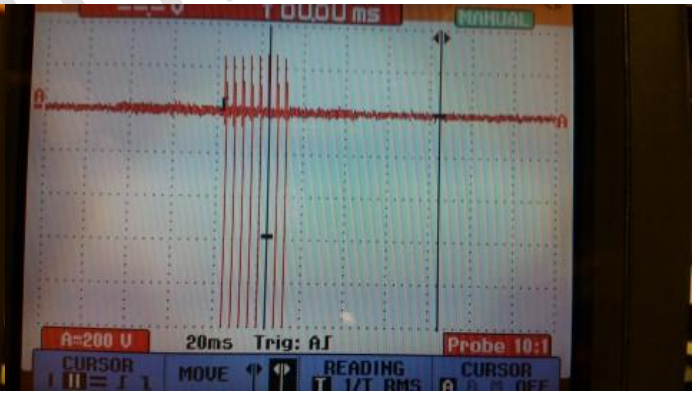
Levels	L1	L2	L5	L10	L15	L20	L25	L30	L35	L40	L45	L50	L55	L60	L65	L70	L75	L80	L85	L90	L95	L100
PE-900-10MOhm	0	72	312	556	776	1000	1220	1420	1620	1800	1920	2160	2340	2600	2860	3120	3560	3760	3960	4200	4560	4840
PE-900-100kOhm				216		352		440		528		592		720		856		1000		1200		1400

2. **Do we get the same voltage when we tap several times?** Yes, stable
3. **How does the amplitude look like and is it AC or DC?**
   ONE tap on the remote control (**NO** continous stim, only **ONE** tap single stimulation) exists of a series of impulses. In the previous e-collars that amount stayed the same on the different levels but with the PE-900 there is a difference in the amount of impulses when pushing the button on the different levels.
   Single stimulation on the different levels:
   L1 – L51 ➔ 5 single impulses with a timeframe of 125 µsec. and an interval of 4 msec.
   L52 – L100 ➔ 8 single impulses
   In cont. stimulation there are bursts with a different amount of amplitudes
   L1 – L40 ➔ 5 single impulses
   L41 – L75 ➔ 6 single impulses
   L76 – L100 ➔ 7 single impulses

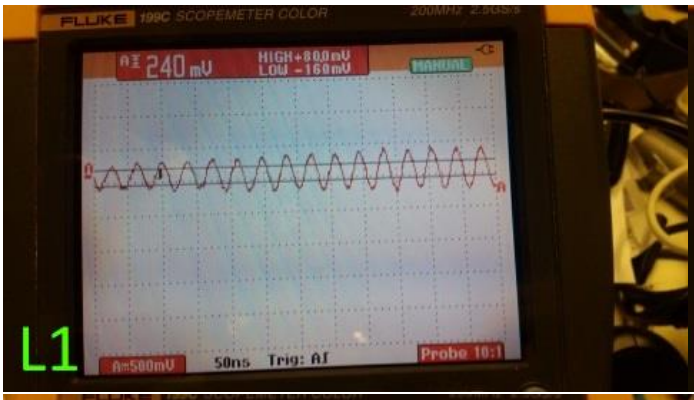
Example 1 lower level ➔ less impulses

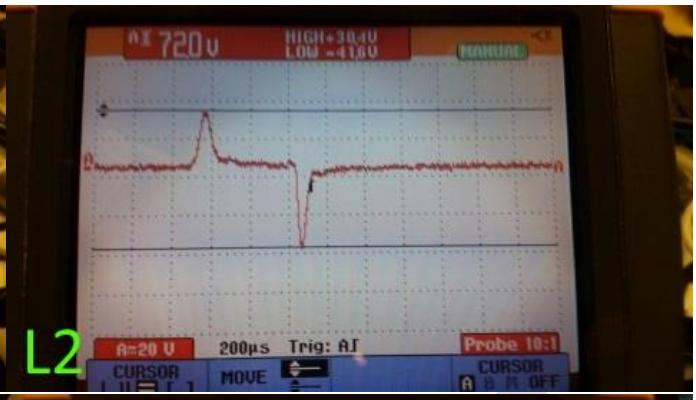


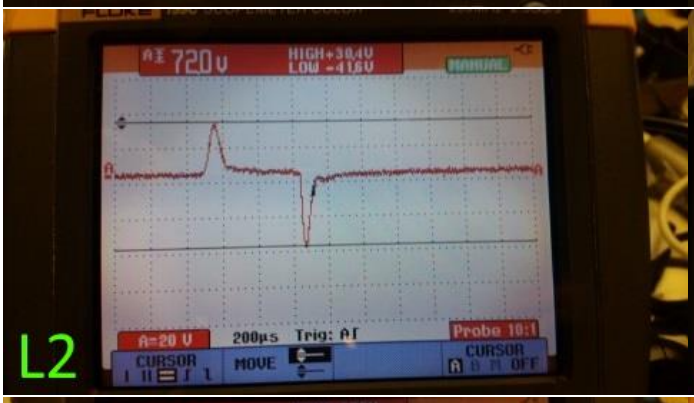
Example 2 higher level ➔ more impulses



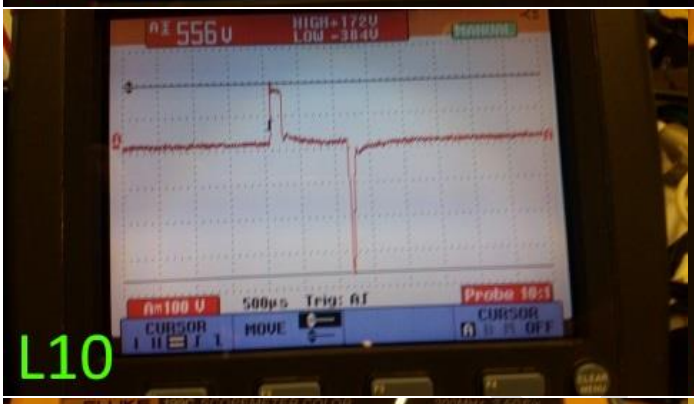
   When we zoom in on that image and look at one single vertical line then we can see how **ONE** impulse looks like (images below, starting with "L1").
   Is that shape **AC** or **DC**? The shape at L1 is AC, that is how a sinusoidal sine wave looks like in AC but the value in Volts is too low to feel. Starting from L2, the AC sine wave is gone and changed to a periodic non-sinusoidal waveform and the flat wave gets wider as the levels get higher so I guess that's what they call the "blunt stimulation"? Theoretically speaken you can say it is AC because it is repetitive and the polarity changes but it's not a nice smooth wave. With the PE-900 from e-collar technologies you can see –just as with the Dogtra- that on the most levels in one single impulse you get a flat wave and a peak. In my experience, the peak you see is the pinprick you feel when you test the e-collar on yourself at a higher level. I don't consider this as a problem because of the 100 levels this e-collar has so I also believe that you can establish smooth communication with this e-collar when training your dog.

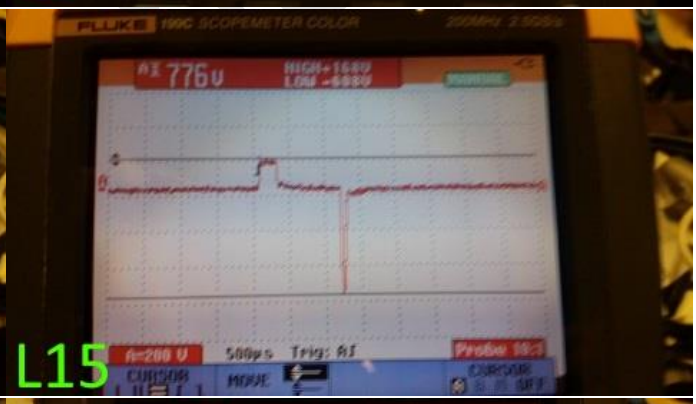

L1

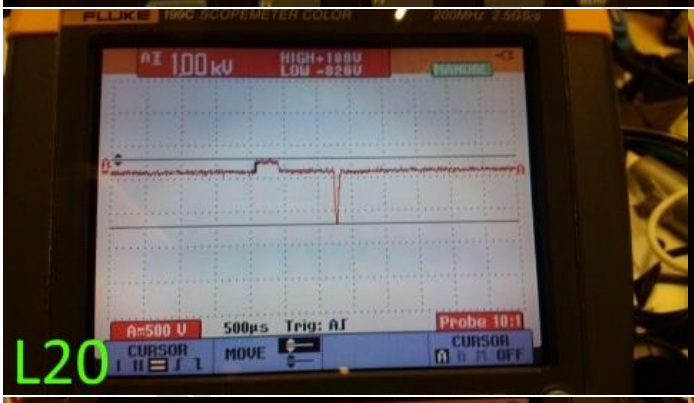

L2

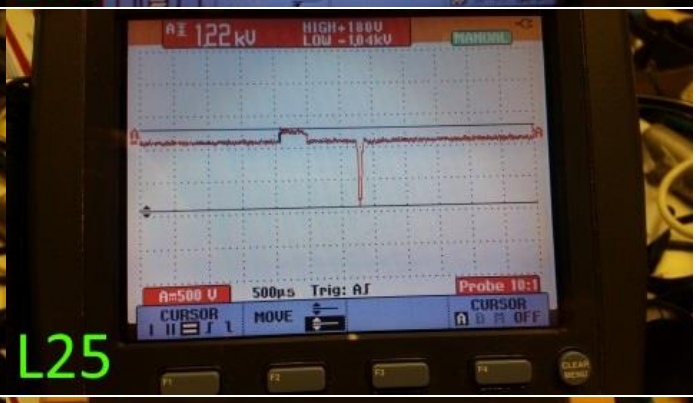

L2

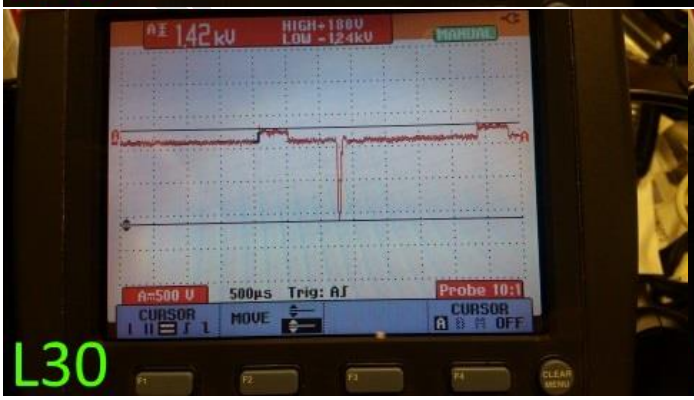

L5

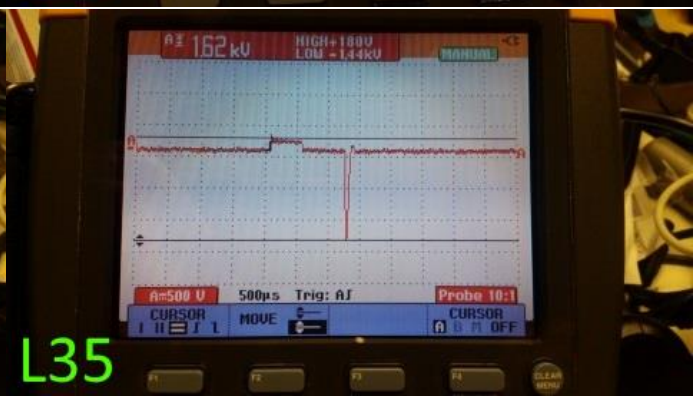

L10

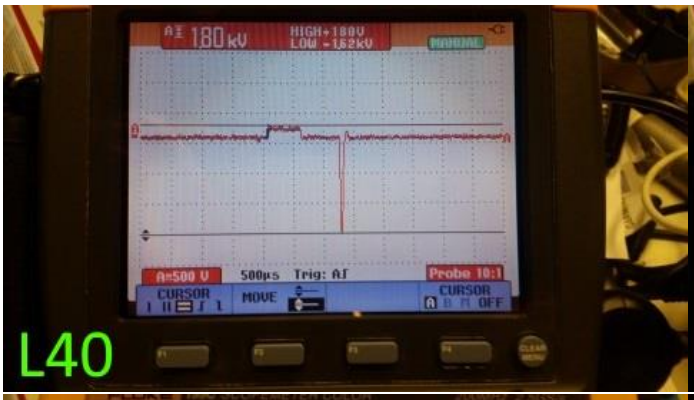

L15


L20

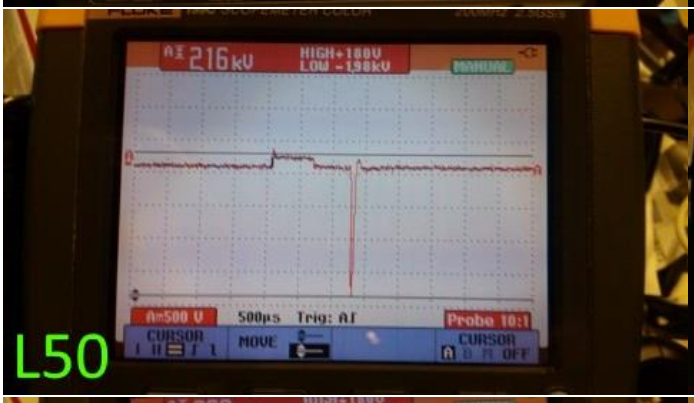

L25

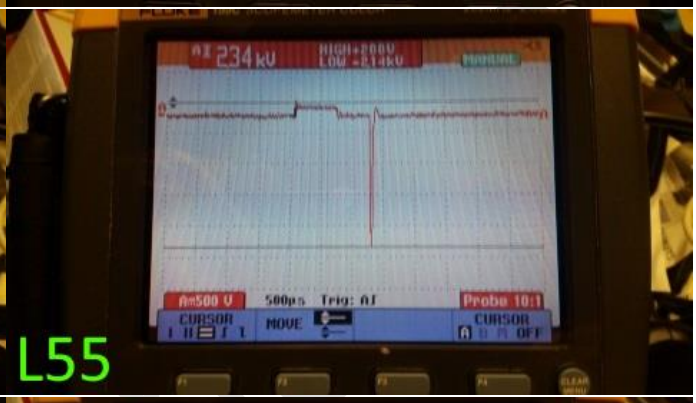

L30

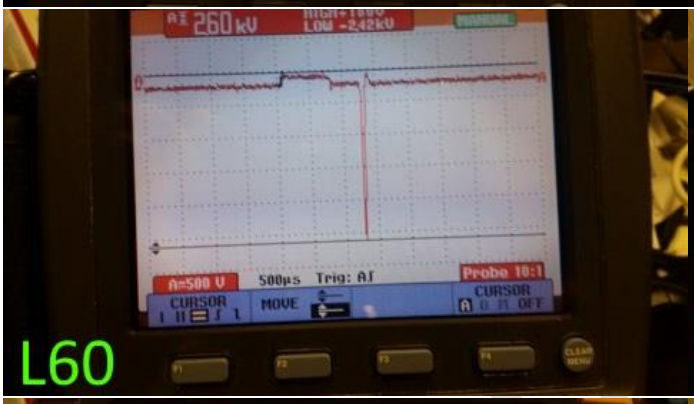

L35

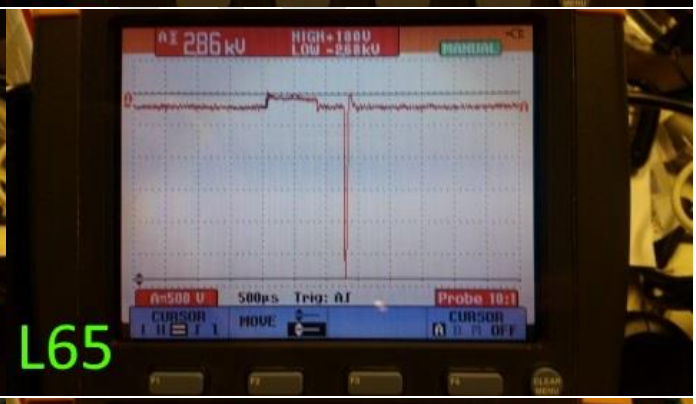

180 kV
HIGH+180V
LOW -162kV
MANUAL
A=500 V
500µs Trig: AI
Probe 10:1
CURSOR
MOVE
CURSOR
OFF
L40

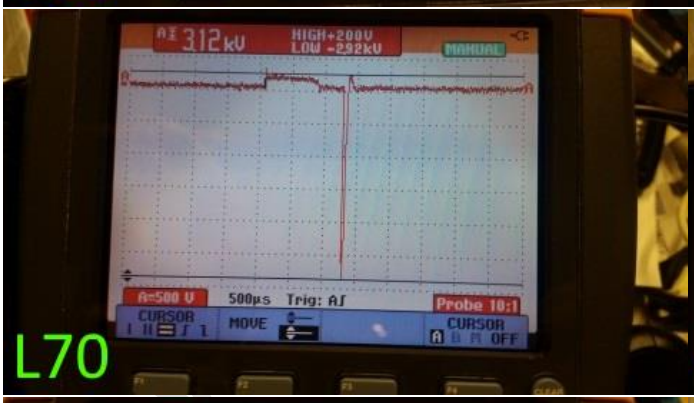

192 kV
HIGH+180V
LOW -174kV
MANUAL
A=500 V
500µs Trig: AI
Probe 10:1
CURSOR
MOVE
CURSOR
OFF
L45

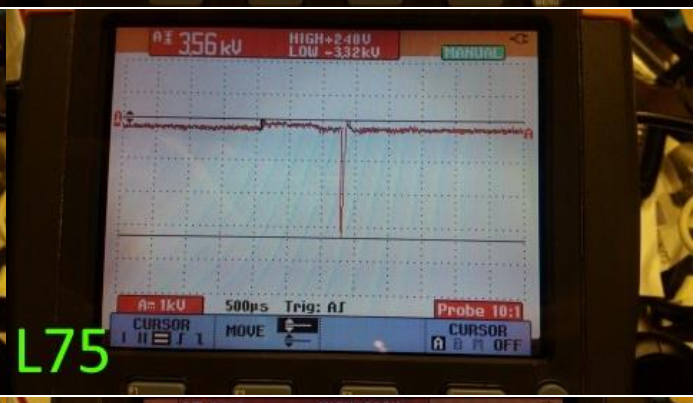

216 kV
HIGH+180V
LOW -198kV
MANUAL
A=500 V
500µs Trig: AI
Probe 10:1
CURSOR
MOVE
CURSOR
OFF
L50

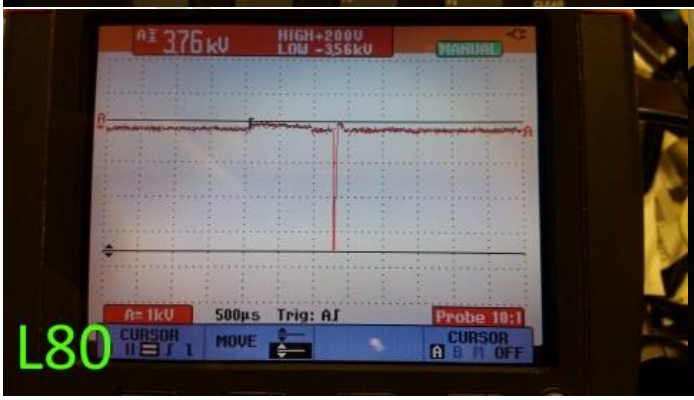

234 kV
HIGH+200V
LOW -214kV
MANUAL
A=500 V
500µs Trig: AI
Probe 10:1
CURSOR
MOVE
CURSOR
OFF
L55

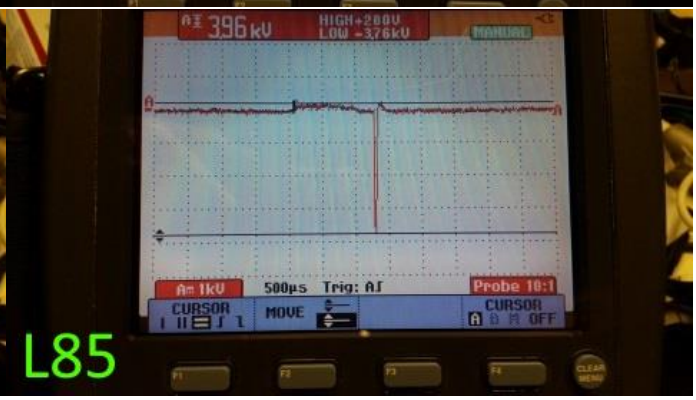

260 kV
LOW -242kV
MANUAL
A=500 V
500µs Trig: AI
Probe 10:1
CURSOR
MOVE
CURSOR
OFF
L60

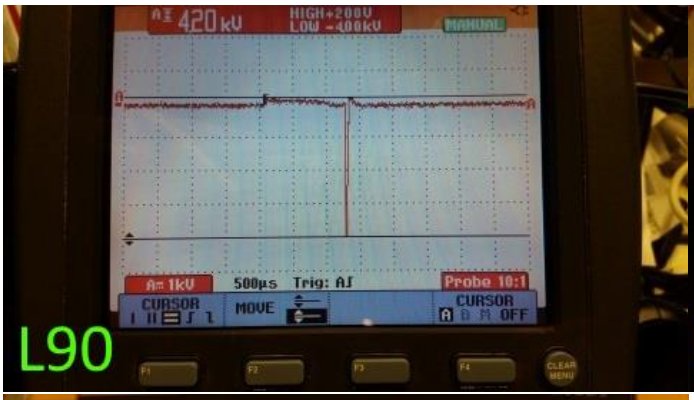

286 kV
HIGH+180V
LOW -288kV
MANUAL
A=500 V
500µs Trig: AI
Probe 10:1
CURSOR
MOVE
CURSOR
OFF
L65

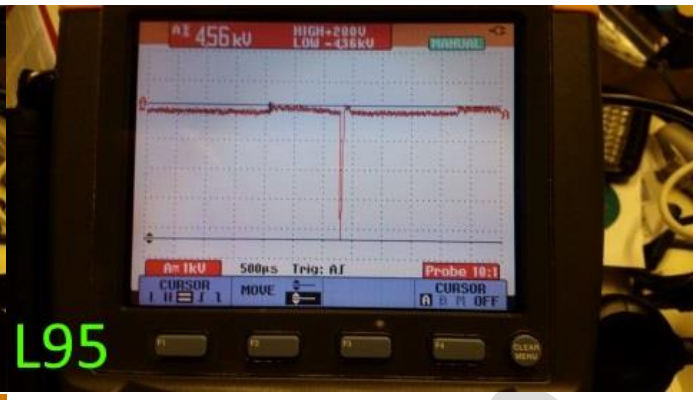

312 kV
HIGH+200V
LOW -292kV
MANUAL
A=500 V
500µs Trig: AI
Probe 10:1
CURSOR
MOVE
CURSOR
OFF
L70

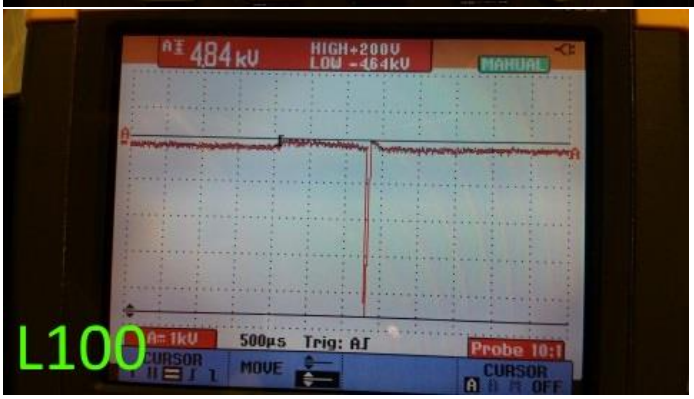

356 kV
HIGH+240V
LOW -332kV
MANUAL
A= 1kV
500µs Trig: AI
Probe 10:1
CURSOR
MOVE
CURSOR
OFF
L75


376 kV
HIGH+200V
LOW -356kV
MANUAL
A= 1kV
500µs Trig: AI
Probe 10:1
CURSOR
MOVE
CURSOR
OFF
L80


396 kV
HIGH+280V
LOW -376kV
MANUAL
A= 1kV
500µs Trig: AI
Probe 10:1
CURSOR
MOVE
CURSOR
OFF
L85

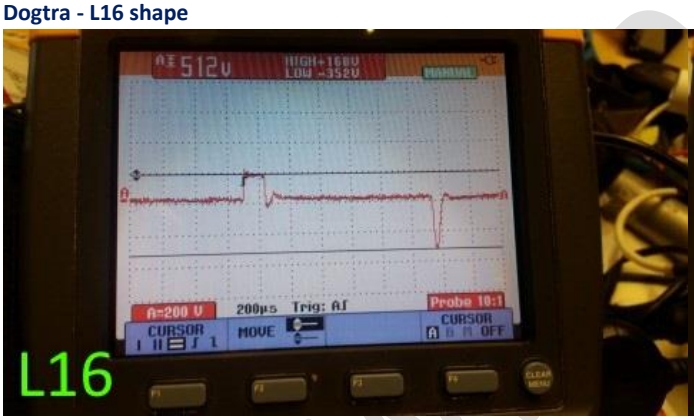




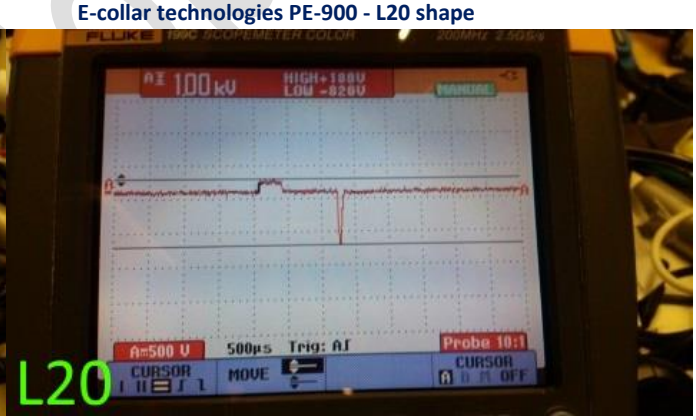


The PE-900 waveform has similarities with the Dogtra waveform. I wonder if the 2 brands use any similar technology or components. For example, if you compare the Dogtra on L16 and the PE-900 on L20 you see something similar::

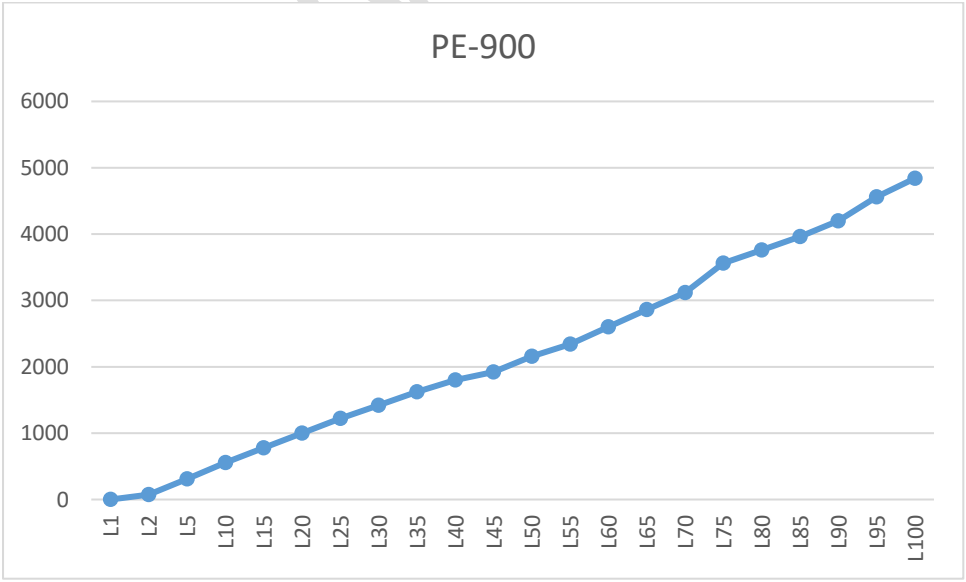
Dogtra - L16 shape



E-collar technologies PE-900 - L20 shape



The signal in the PE-900 is a little bit different/cleaner/neater but the different amount of impulses in the different levels make it a different product too.



4. **Does the amplitude change with a different resistance (dog in water = lower resistance and can that influence the impulse)?**
   The signal stays the same (less than 10% difference with a higher resistance).
5. **Does the amplitude/voltage remain stable when using continuous stim?**
   Yes, continuous stim is a burst of impulses at an interval.

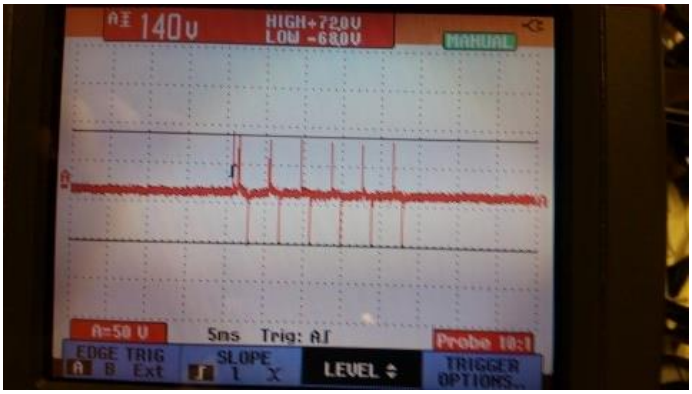
6. **What is the timeframe from one impulse?**
   L1 – L51 ➔ 5 impulses with a timeframe of 125 µsec. and an interval of 4 msec.
   I assume that the timeframe doesn't change on the different levels.

E-COLLAR TECHNOLOGIES mini educator ET-300 (100 levels of stimulation)

1. **How big is the voltage in the different levels so that we can use the values for a comparison chart?**
   Remember that the voltage values are not relevant in comparison with a dog because a dog has a much lower resistance than the internal resistance of the oscilloscope.

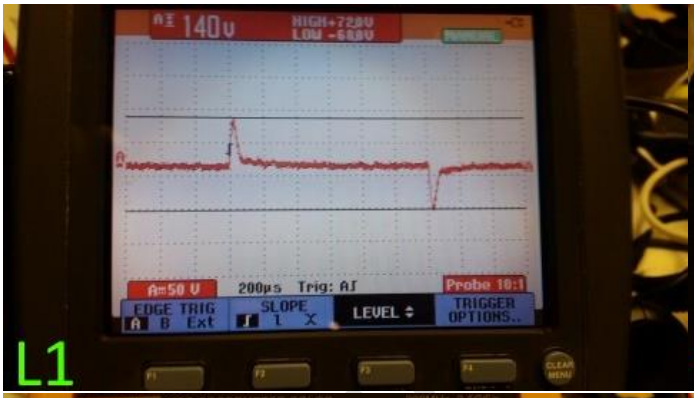
Levels	L1	L10	L20	L30	L40	L50	L60	L70	L80	L90	L100
ET-300	140	616	1030	1500	1900	2180	2640	3280	3880	4440	5040

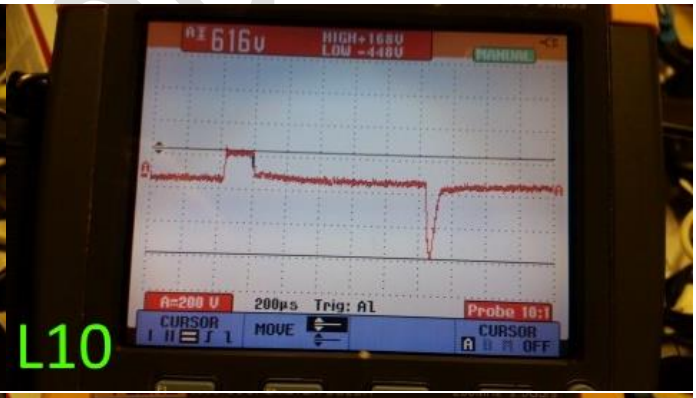
   We checked some values and they seemed to be the same as the PE-900.
   Cont. stimulation behaves the same as the PE-900, bursts with a different amount of impulses. Here at a certain level we see 6 impulses.

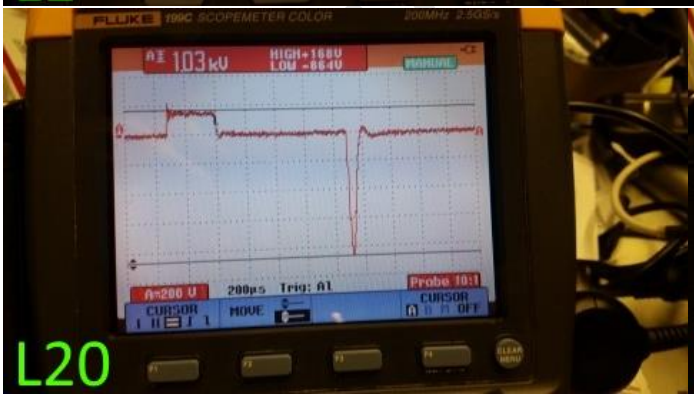


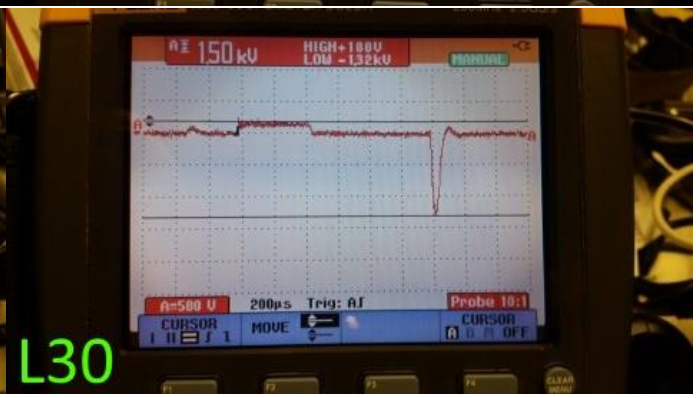
   The difference is in the other features

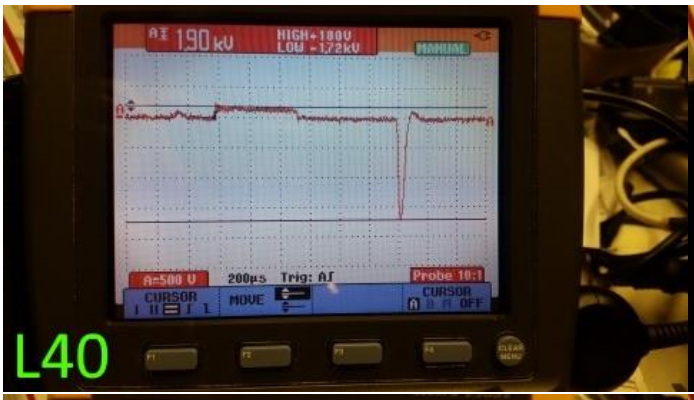
2. **Do we get the same voltage when we tap several times?**
   About the same result as the PE-900
3. **How does the amplitude look like and is it AC or DC?**
   About the same result as the PE-900

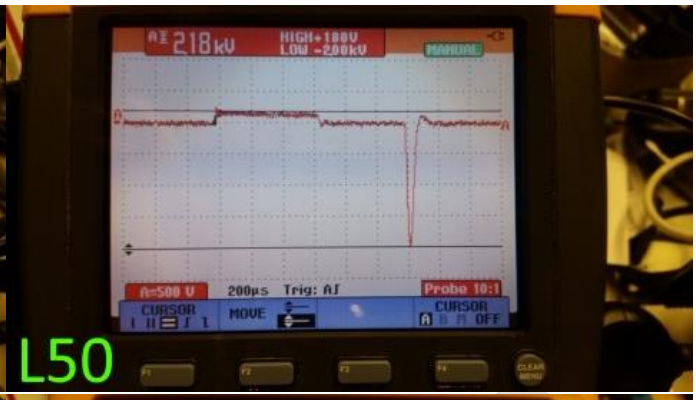


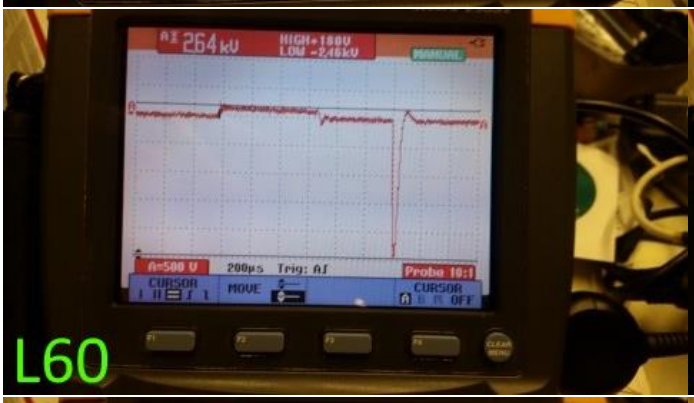


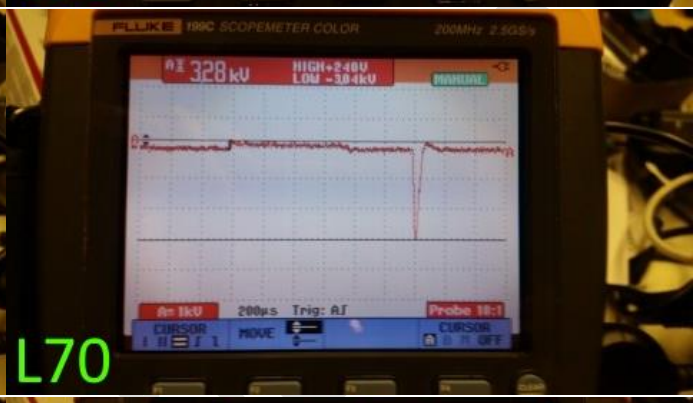


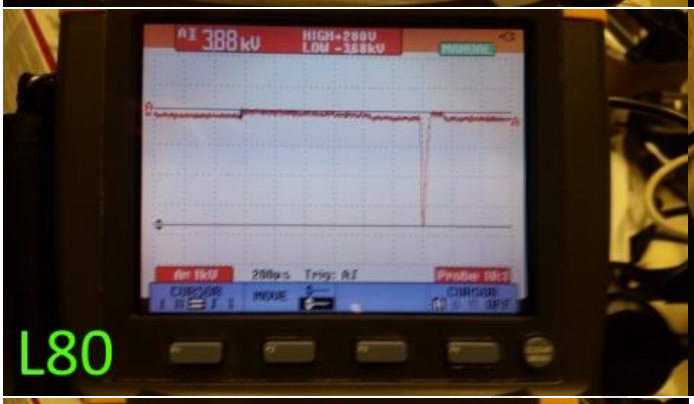


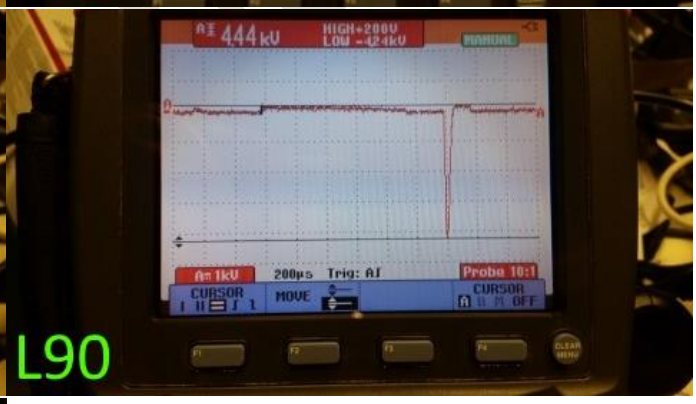

1.90 kV
HIGH +180V
LOW -1.72kV
MANUAL
A=500 V
200µs Trig: Aƒ
Probe 10:1
CURSOR
MOVE
CURSOR
OFF
L40

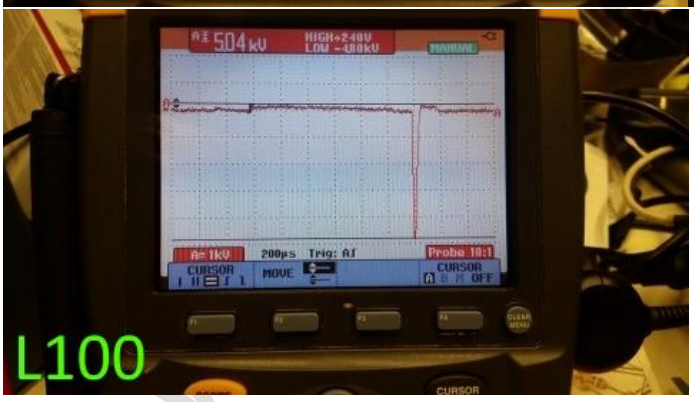

2.18 kV
HIGH +180V
LOW -2.00kV
MANUAL
A=500 V
200µs Trig: Aƒ
Probe 10:1
CURSOR
MOVE
CURSOR
OFF
L50

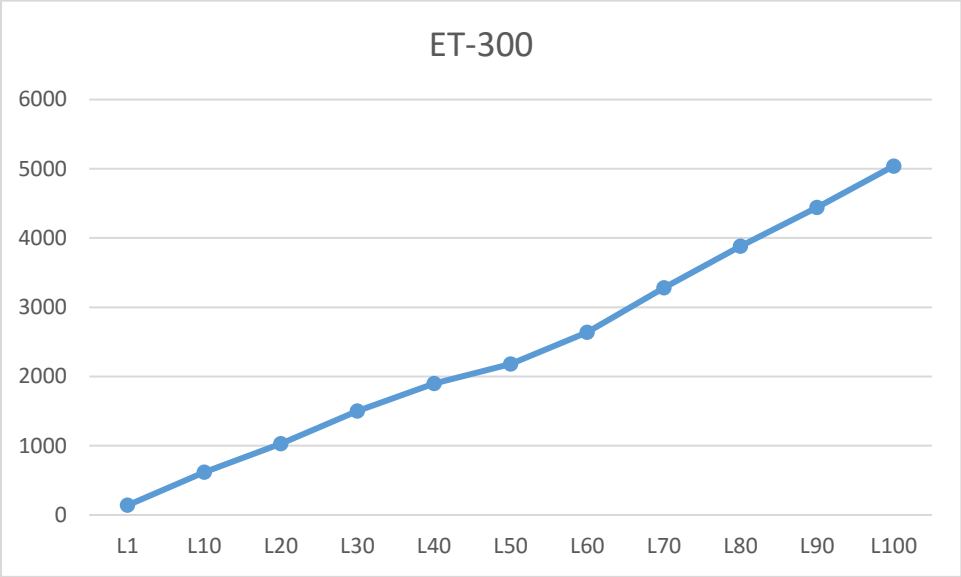

2.64 kV
HIGH +180V
LOW -2.46kV
MANUAL
A=500 V
200µs Trig: Aƒ
Probe 10:1
CURSOR
MOVE
CURSOR
OFF
L60


FLUKE 199C SCOPEMETER COLOR
3.28 kV
HIGH +240V
LOW -3.04kV
MANUAL
A= 1kV
200µs Trig: Aƒ
Probe 10:1
CURSOR
MOVE
CURSOR
OFF
L70


3.88 kV
HIGH +280V
LOW -3.68kV
MANUAL
A= 1kV
200µs Trig: Aƒ
Probe 10:1
CURSOR
MOVE
CURSOR
OFF
L80


4.44 kV
HIGH +280V
LOW -4.24kV
MANUAL
A= 1kV
200µs Trig: Aƒ
Probe 10:1
CURSOR
MOVE
CURSOR
OFF
L90


5.04 kV
HIGH +240V
LOW -4.80kV
MANUAL
A= 1kV
200µs Trig: Aƒ
Probe 10:1
CURSOR
MOVE
CURSOR
OFF
L100



4. **Does the amplitude change with a different resistance (dog in water = lower resistance and can that influence the impulse)?**
   About the same result as the PE-900
5. **Does the amplitude/voltage remain stable when using continuous stim?**
   About the same result as the PE-900
6. **What is the timeframe from one impulse?**
   About the same result as the PE-900

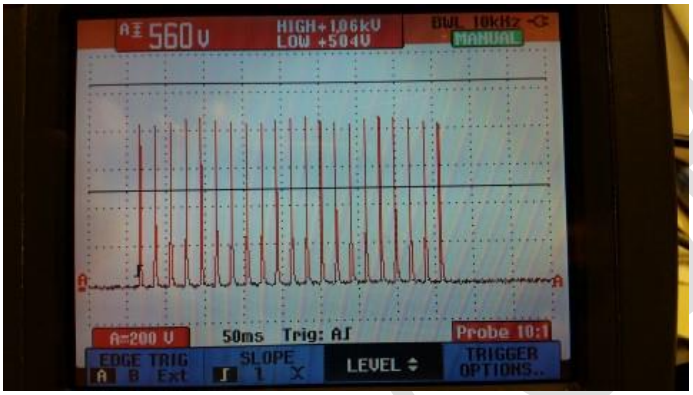
MARTIN SYSTEMS PT3000 (18 levels of stimulation)

1. **How big is the voltage in the different levels so that we can use the values for a comparison chart?**
   Measured with a resistance of 100 kOhm

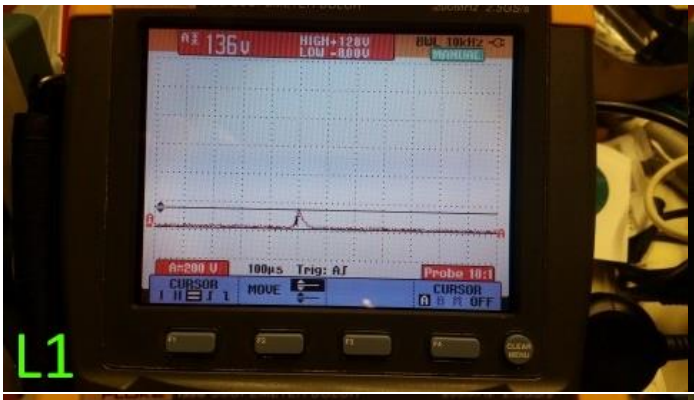
Levels	L1	L2	L3	L4	L5	L6	L7	L8	L9	L10	L11	L12	L13	L14	L15	L16	L17	L18
PT 3000	136	184	376	576	648	648	648	672	728	784	792	792	792	792	792	792	792	792

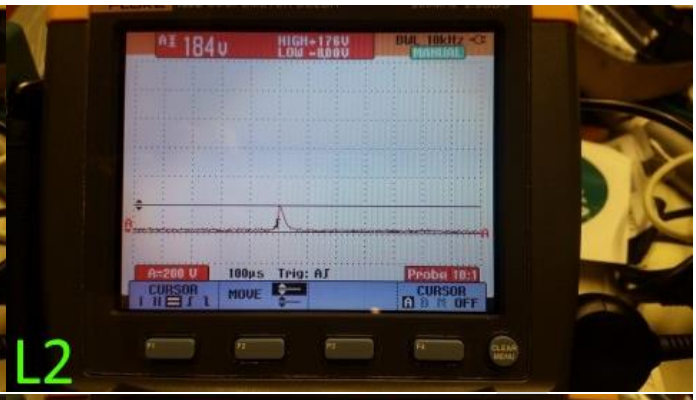
With the Martin System e-collars we noticed a more complex signal in the different levels and with the 10MΩ we sensed something strange in the wave so the electronics engineer applied a filter and we worked with 100 kΩ.
This is the strange behavior, don't know what caused it:

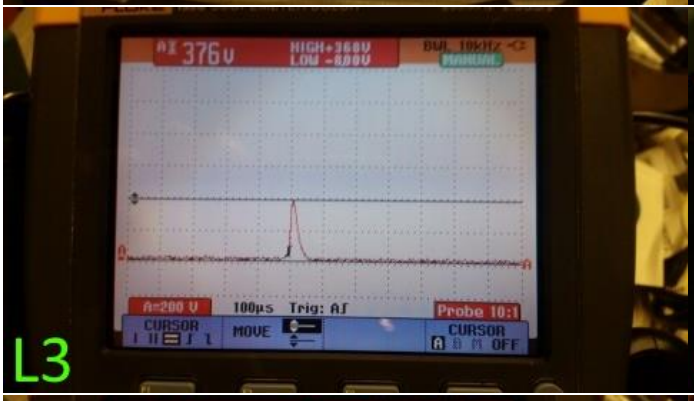
2. **Do we get the same voltage when we tap several times?**
   Yes, stable
3. **How does the amplitude look like and is it AC or DC?**
   ONE tap on the remote control (**NO** continous stim, only **ONE** tap) exists of 21 impulses so one tap on the button looks like this:

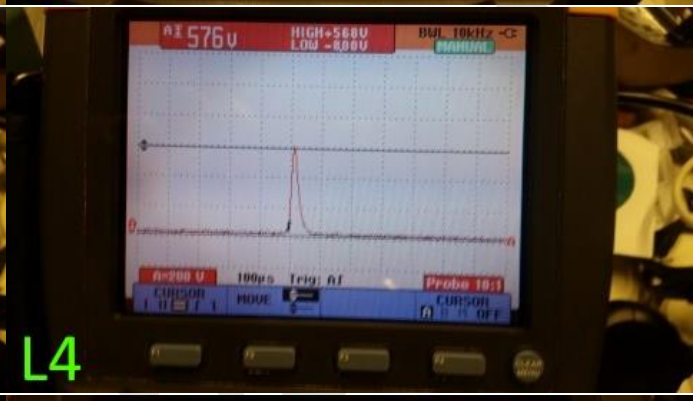


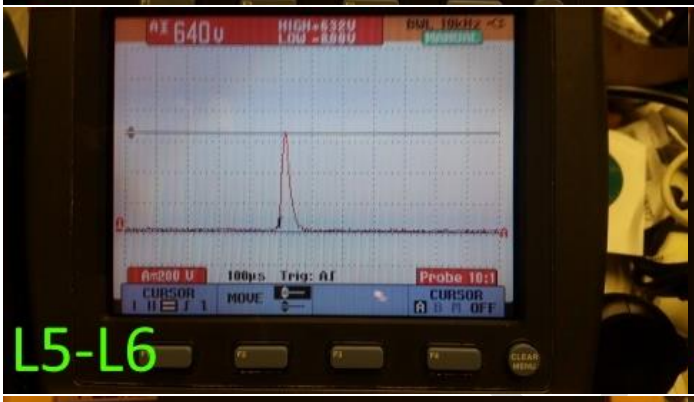
When we zoom in on that image and look at one single vertical line then we can see how **ONE** impulse looks like (images below).
Is that shape **AC** or **DC** ? With Martin System we have a pulsating DC signal, this signal is stable if you compare the different levels. The waveform also looks like the waveform on the muscle stimulator that I tested. With this signal, the waveform gets higher and wider with the higher levels so they use another approach than only more power and a pinprick. With 14 levels this is a good thing too so it seems that with Martin System we do have a different technology.
With Martin System we also noticed a lower voltage (if we compare it with a 100kΩ measurement with another e-collar like the PE-900) so then what's the difference in the feeling? Well, they use a lower voltage but because they "play" with the form of the amplitude, they can change the intensity of the feeling.

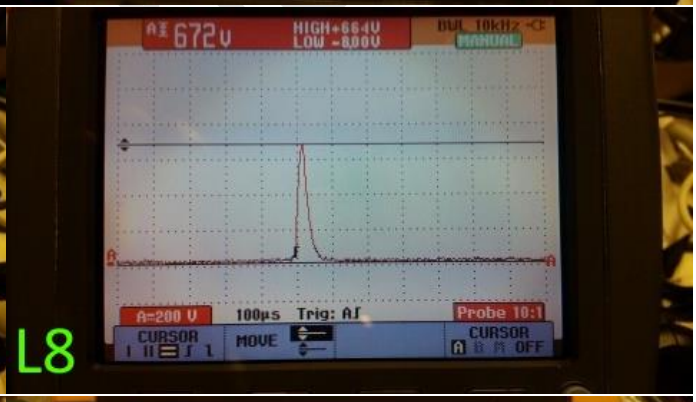

136v
HIGH+128V
LOW -8.00V
A=200 V
100µs Trig: Af
Probe 10:1
CURSOR
MOVE
L1

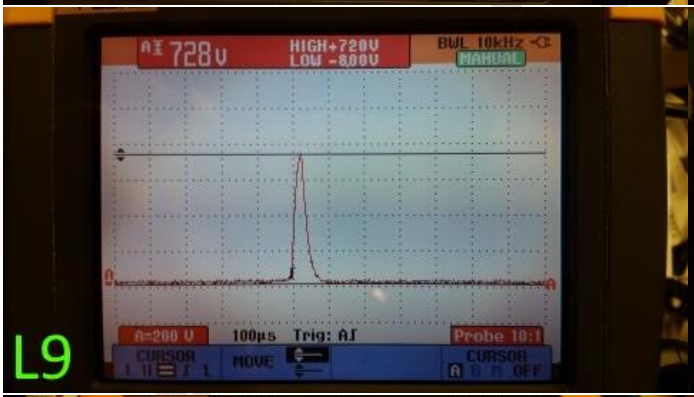

184v
HIGH+176V
LOW -8.00V
A=200 V
100µs Trig: Af
Probe 10:1
CURSOR
MOVE
L2

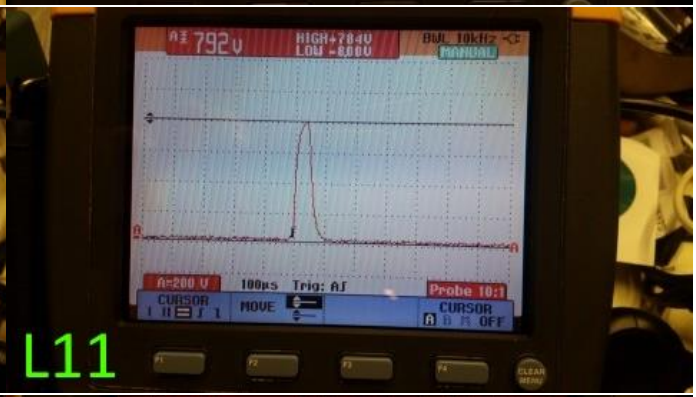

376v
HIGH+368V
LOW -8.00V
A=200 V
100µs Trig: Af
Probe 10:1
CURSOR
MOVE
L3

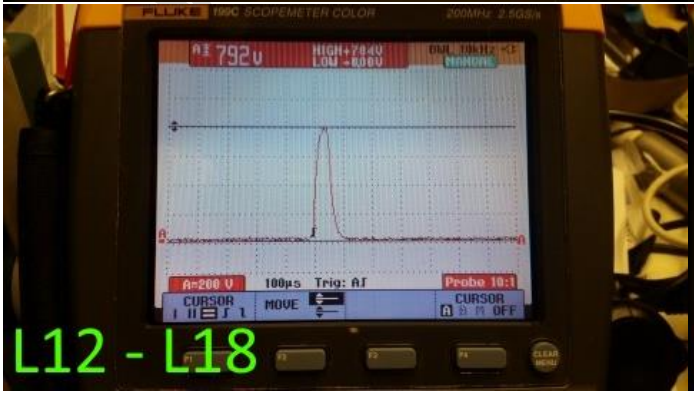

576v
HIGH+568V
LOW -8.00V
A=200 V
100µs Trig: Af
Probe 10:1
CURSOR
MOVE
L4

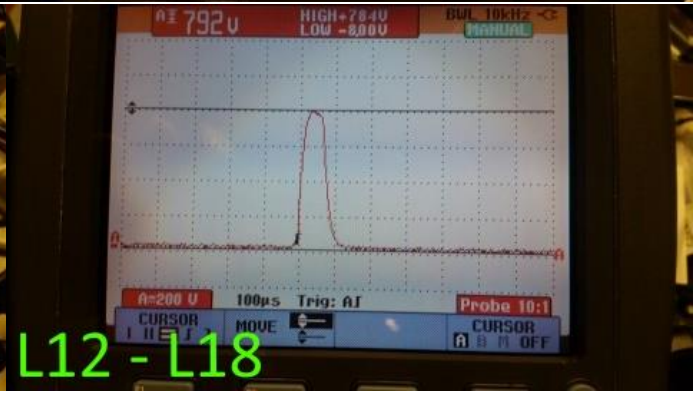

640v
A=200 V
100µs Trig: Af
Probe 10:1
CURSOR
MOVE
L5-L6

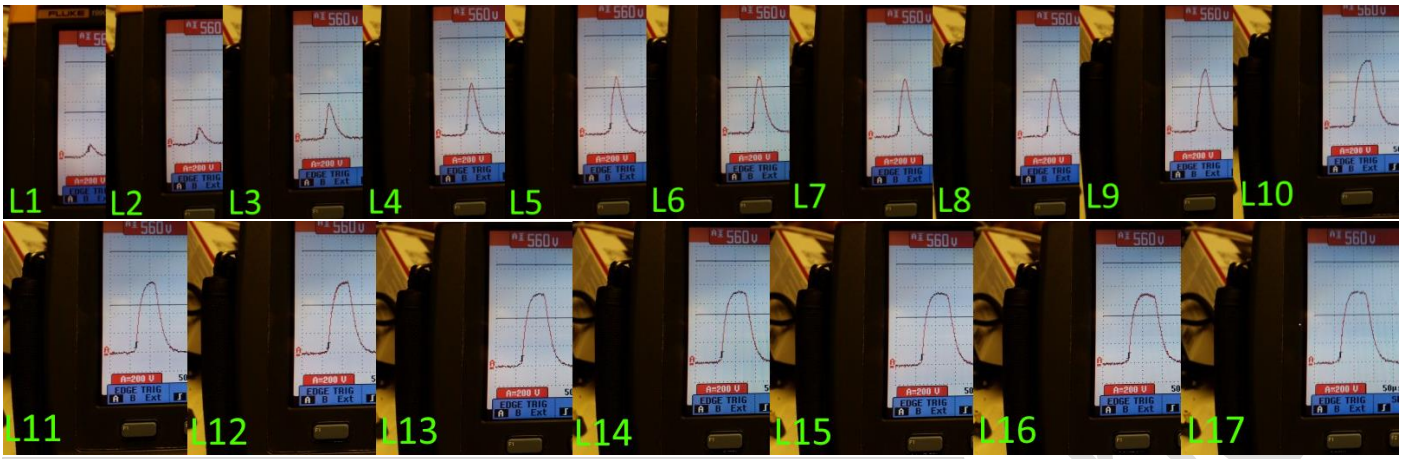

672v
HIGH+664V
LOW -8.00V
A=200 V
100µs Trig: Af
Probe 10:1
CURSOR
MOVE
L8

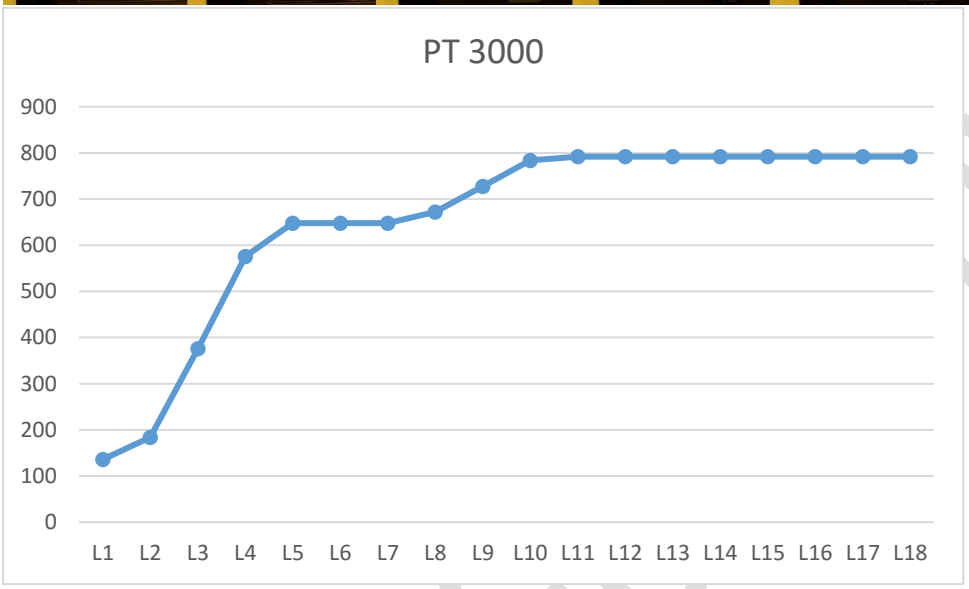

728v
HIGH+720V
LOW -8.00V
BWL 10kHz
MANUAL
A=200 V
100µs Trig: Af
Probe 10:1
CURSOR
MOVE
L9


792v
HIGH+784V
LOW -8.00V
A=200 V
100µs Trig: Af
Probe 10:1
CURSOR
MOVE
L11

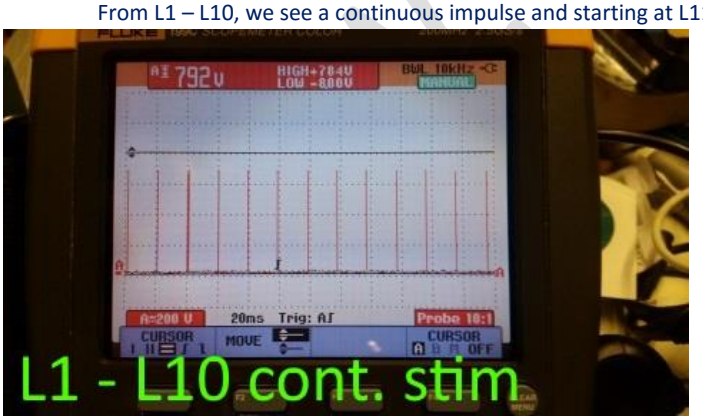

792v
HIGH+784V
LOW -8.00V
A=200 V
100µs Trig: Af
Probe 10:1
CURSOR
MOVE
L12 - L18


792v
HIGH+784V
LOW -8.00V
A=200 V
100µs Trig: Af
Probe 10:1
CURSOR
MOVE
L12 - L18

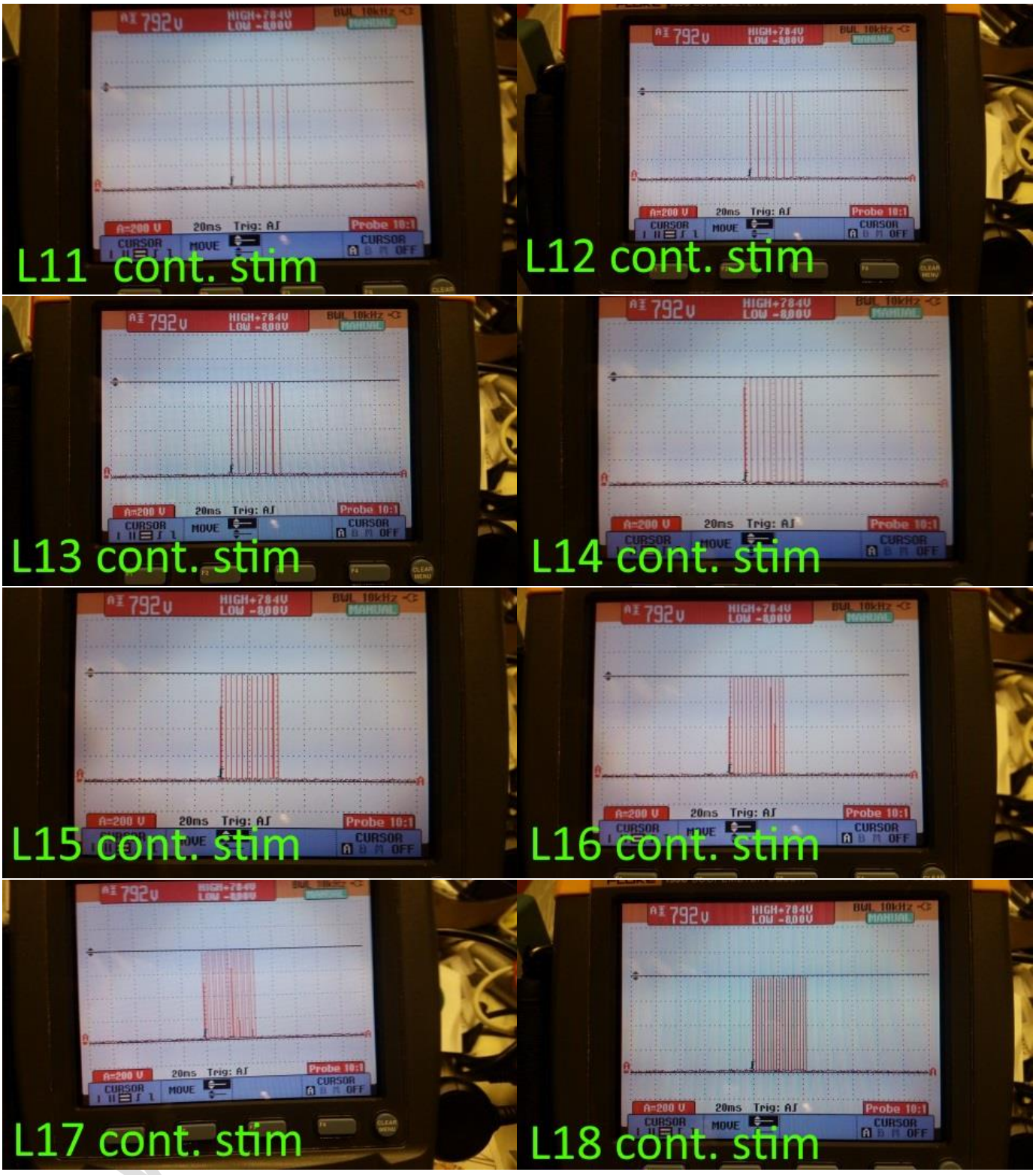




4. **Does the amplitude change with a different resistance (dog in water = lower resistance and can that influence the impulse)?**
   No, stable waveform
5. **Does the amplitude/voltage remain stable when using continuous stim?**
   The impulse stays the same, however we get a different impulse signal starting at L11.
   From L1 – L10, we see a continuous impulse and starting at L11 we see a burst.



Starting at L11 we see a burst of multiple impulses (3 to 4 impulses) on a distance from each other (interval of 280msec.)



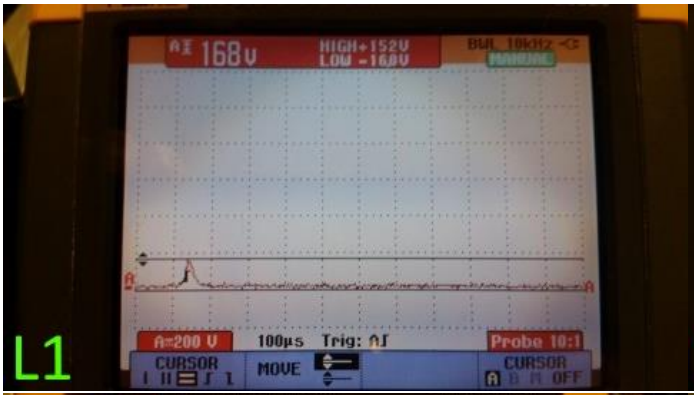
6. **What is the timeframe from one impulse?**
   With Martin System this changes a lot, it looks like they use the width and the duration of the pulse to change the feeling.

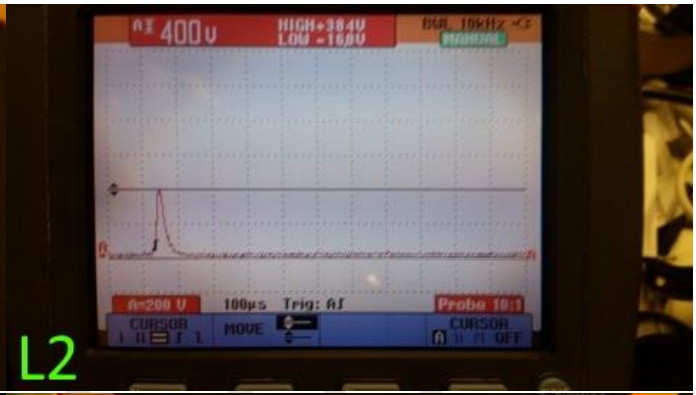
MARTIN SYSTEMS TT1000 (8 levels of stimulation)

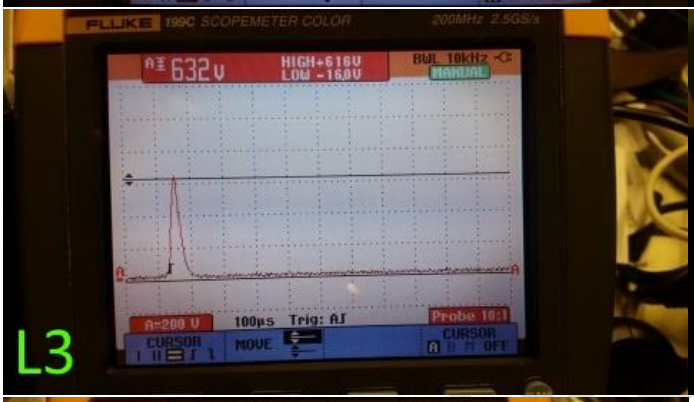
1. **How big is the voltage in the different levels so that we can use the values for a comparison chart?**

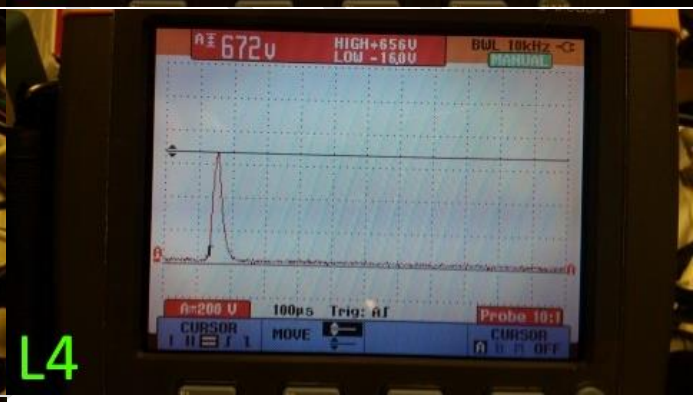
Levels	L1	L2	L3	L4	L5	L6	L7	L8	L9
TT1000	168	400	632	672	776	776	776	776	776

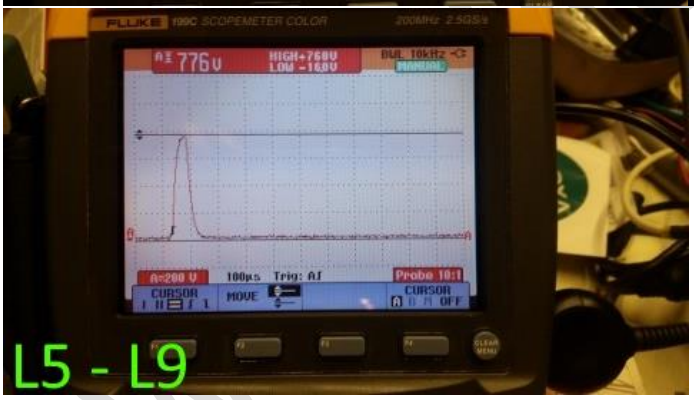
2. **Do we get the same voltage when we tap several times?**
   Yes, stable
3. **How does the amplitude look like and is it AC or DC?**
   The waveform is the same as the PT 3000 but there are less levels.
   The width and the duration of the waveform differs as the levels go up.



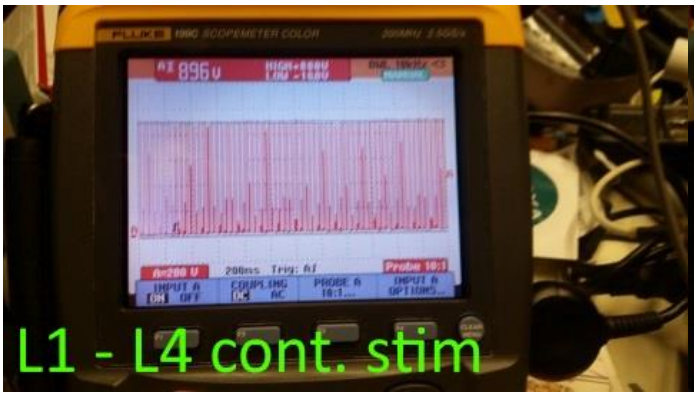


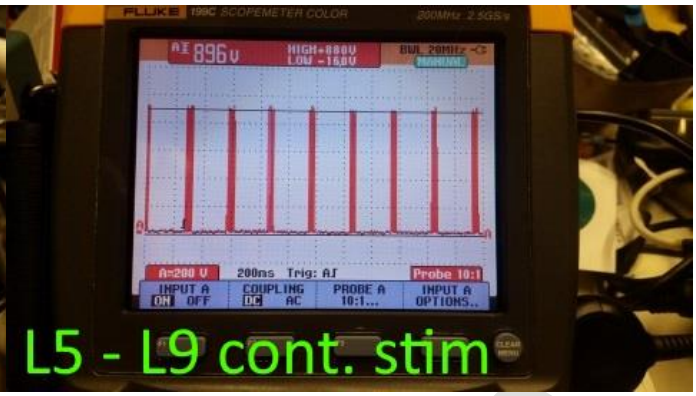






4. **Does the amplitude change with a different resistance (dog in water = lower resistance and can that influence the impulse)?**
   No, stable waveform
5. **Does the amplitude/voltage remain stable when using continuous stim?**
   Yes, but again we have a different signal at a certain level.
   From L1 – L4 we see a continuous signal and starting at L5 we see bursts (like a pulse train)





6. **What is the timeframe from one impulse?**

With Martin System this changes a lot, it looks like they use the pulse width and duration to change the feeling.

- L1 - L5 we measured 19,4msec. between 2 impulses
- L6 – 8 msec.
- L7 – 4,5 msec.
- L8 – 3,2 msec.
- L9 – 2,8 msec.

Comparison chart with all values

Levels	L1	L8	L16	L24	L32	L40	L48	L56	L64	L72	L80	L88	L96	L104	L112	L120	L127
Dogtra 620 NCP (127 levels)	170	340	512	700	860	1000	1300	1700	2000	2320	2700	3000	3700	4360	4560	4560	4560

Levels	L1	L10	L20	L30	L40	L50	L60	L70	L80	L90	L100
E-collar tech ET-300 (100 levels)	140	616	1030	1500	1900	2180	2640	3280	3880	4440	5040

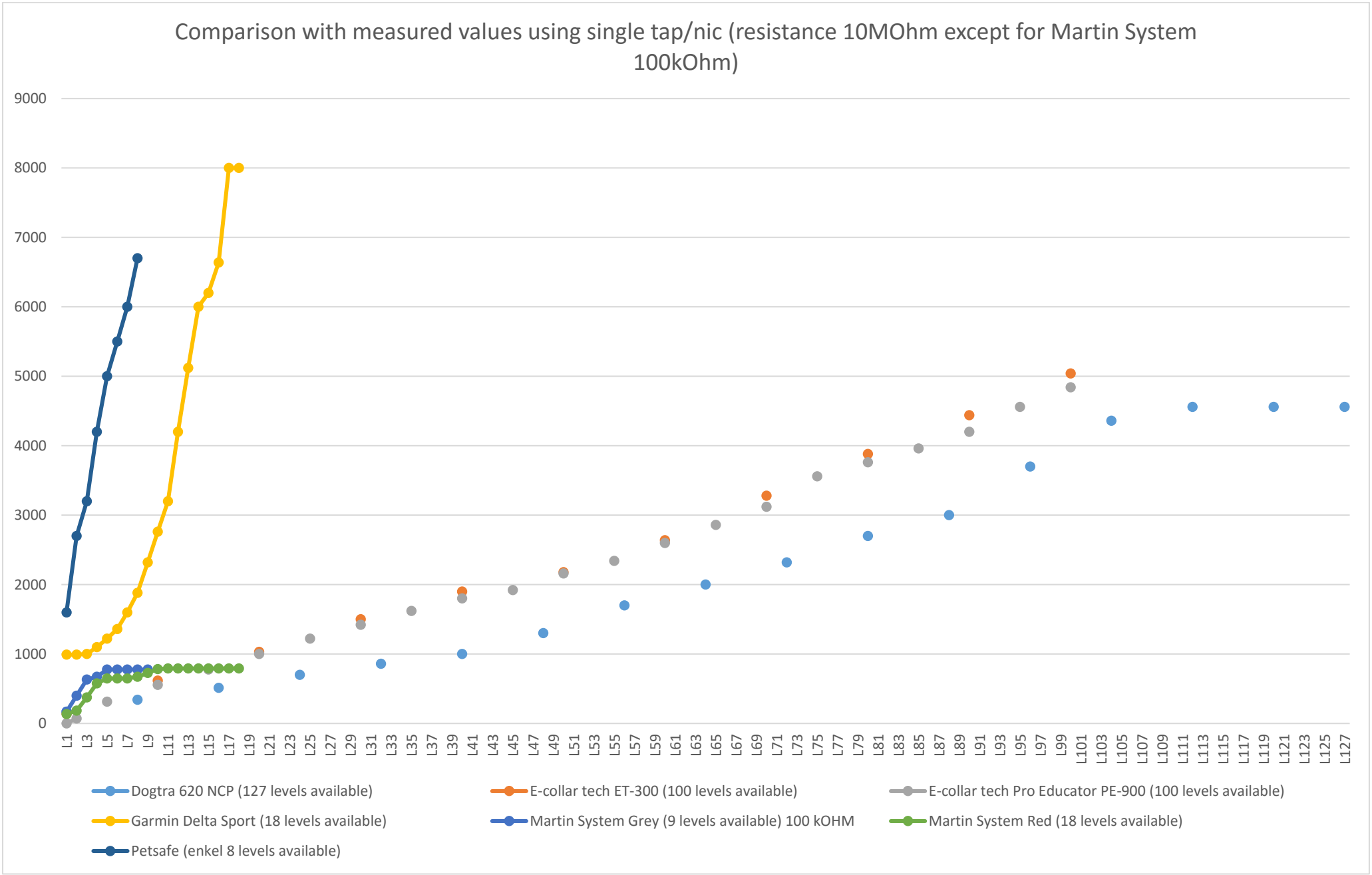
Levels	L1	L2	L5	L10	L15	L20	L25	L30	L35	L40	L45	L50	L55	L60	L65	L70	L75	L80	L85	L90	L95	L100
E-collar tech Pro Educator PE-900 (100 levels)	0	72	312	556	776	1000	1220	1420	1620	1800	1920	2160	2340	2600	2860	3120	3560	3760	3960	4200	4560	4840

Levels	L1	L2	L3	L4	L5	L6	L7	L8	L9	L10	L11	L12	L13	L14	L15	L16	L17	L18
Garmin Delta Sport (18 levels)	992	992	1000	1100	1220	1360	1600	1880	2320	2760	3200	4200	5120	6000	6200	6640	8000	8000

Levels	L1	L2	L3	L4	L5	L6	L7	L8	L9
Martin System Grey (9 levels) 100 kOHM	168	400	632	672	776	776	776	776	776

Levels	L1	L2	L3	L4	L5	L6	L7	L8	L9	L10	L11	L12	L13	L14	L15	L16	L17	L18
Martin System Red (18 levels)	136	184	376	576	648	648	648	672	728	784	792	792	792	792	792	792	792	792

Levels	L1	L2	L3	L4	L5	L6	L7	L8
Petsafe (8 levels)	1600	2700	3200	4200	5000	5500	6000	6700


Comparison with measured values using single tap/nic (resistance 10MOhm except for Martin System 100kOhm)
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
L1 L3 L5 L7 L9 L11 L13 L15 L17 L19 L21 L23 L25 L27 L29 L31 L33 L35 L37 L39 L41 L43 L45 L47 L49 L51 L53 L55 L57 L59 L61 L63 L65 L67 L69 L71 L73 L75 L77 L79 L81 L83 L85 L87 L89 L91 L93 L95 L97 L99 L101 L103 L105 L107 L109 L111 L113 L115 L117 L119 L121 L123 L125 L127
Dogtra 620 NCP (127 levels available)
E-collar tech ET-300 (100 levels available)
E-collar tech Pro Educator PE-900 (100 levels available)
Garmin Delta Sport (18 levels available)
Martin System Grey (9 levels available) 100 kOHM
Martin System Red (18 levels available)
Petsafe (enkel 8 levels available)

Comparison chart with all values measured with only the internal resistance of the oscilloscope (10MΩ)

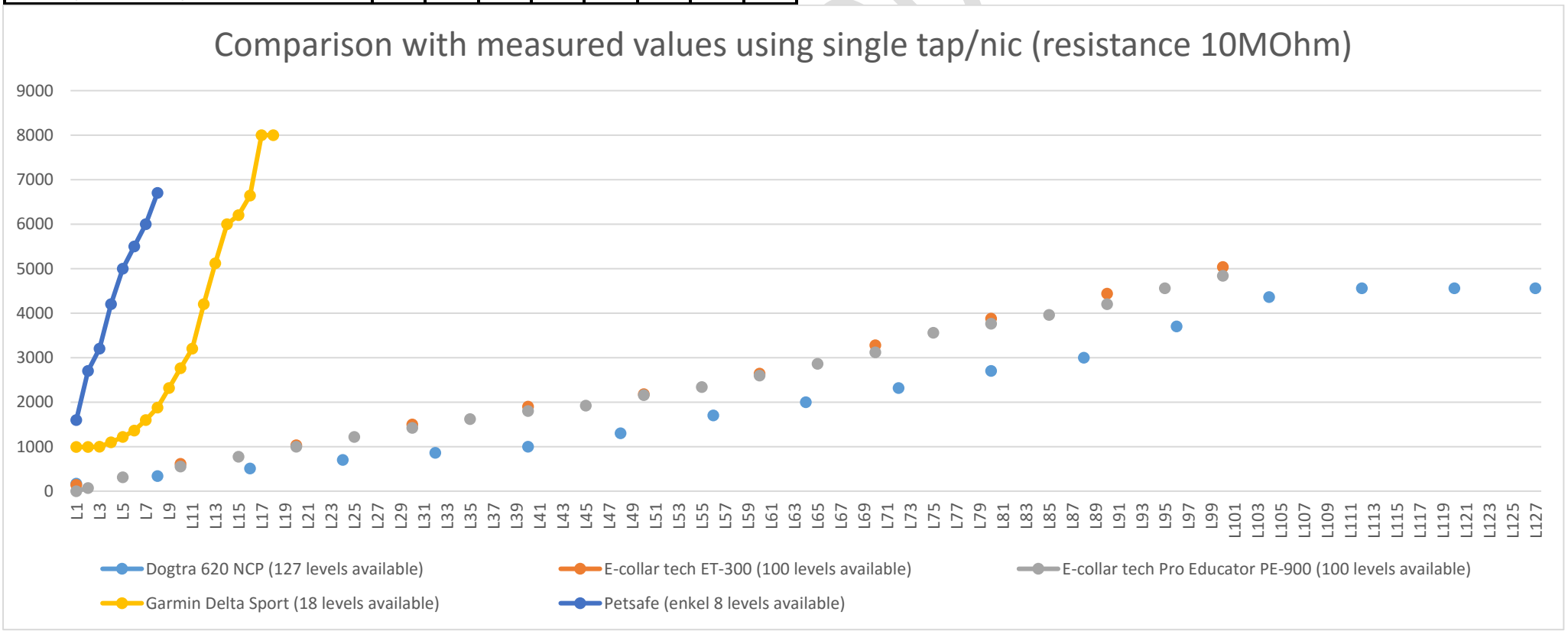
number of available levels	L1	L8	L16	L24	L32	L40	L48	L56	L64	L72	L80	L88	L96	L104	L112	L120	L127
Dogtra 620 NCP (127 levels)	170	340	512	700	860	1000	1300	1700	2000	2320	2700	3000	3700	4360	4560	4560	4560

number of available levels	L1	L10	L20	L30	L40	L50	L60	L70	L80	L90	L100
E-collar tech ET-300 (100 levels)	140	616	1030	1500	1900	2180	2640	3280	3880	4440	5040

number of available levels	L1	L2	L5	L10	L15	L20	L25	L30	L35	L40	L45	L50	L55	L60	L65	L70	L75	L80	L85	L90	L95	L100
E-collar tech Pro Educator PE-900 (100 levels)	0	72	312	556	776	1000	1220	1420	1620	1800	1920	2160	2340	2600	2860	3120	3560	3760	3960	4200	4560	4840

number of available levels	L1	L2	L3	L4	L5	L6	L7	L8	L9	L10	L11	L12	L13	L14	L15	L16	L17	L18
Garmin Delta Sport (18 levels)	992	992	1000	1100	1220	1360	1600	1880	2320	2760	3200	4200	5120	6000	6200	6640	8000	8000

number of available levels	L1	L2	L3	L4	L5	L6	L7	L8
Petsafe (enkel 8 levels)	1600	2700	3200	4200	5000	5500	6000	6700

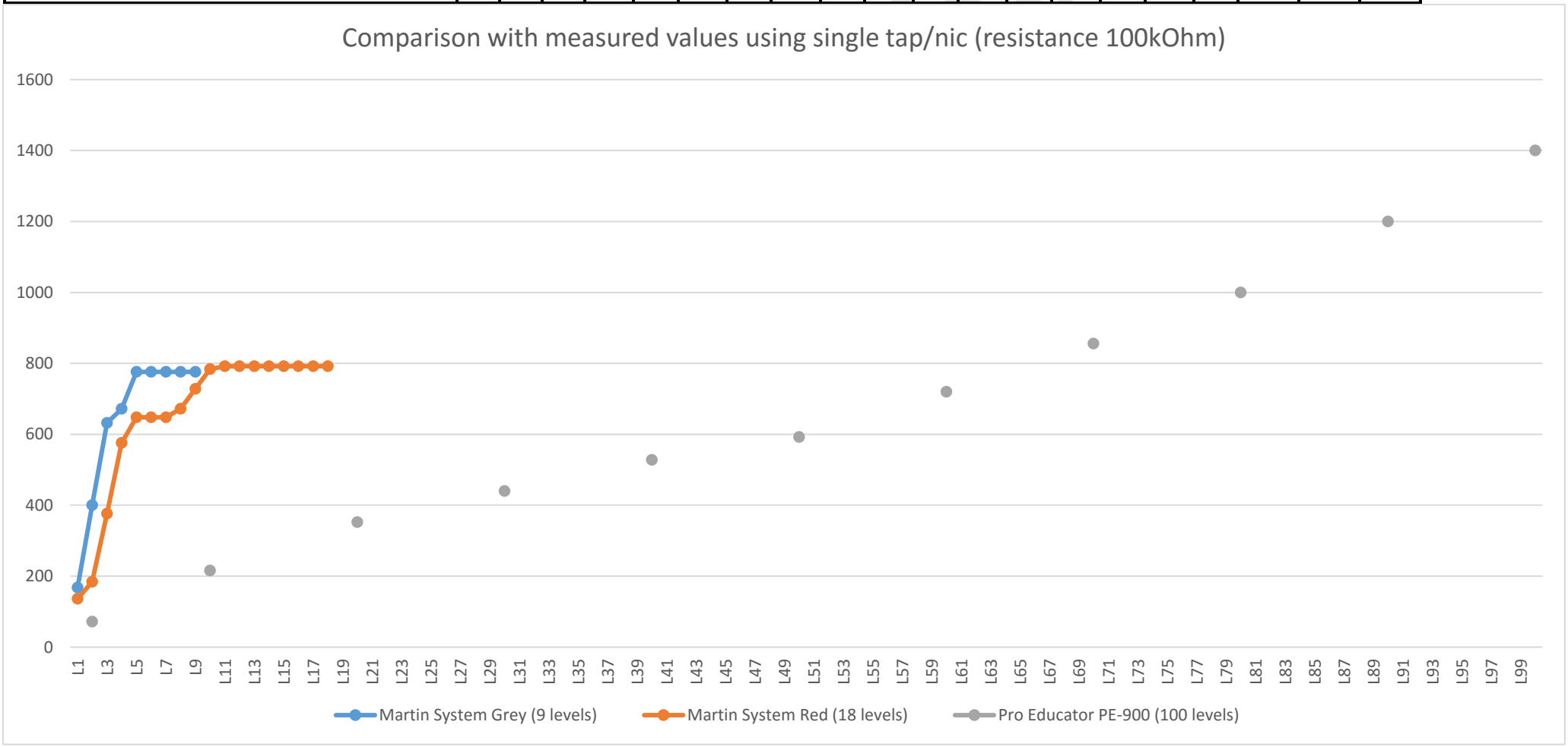


Comparison chart with all values measured at 100 kΩ

number of available levels	L1	L2	L3	L4	L5	L6	L7	L8	L9
Martin System Grey (9 levels) 100 kOHM	168	400	632	672	776	776	776	776	776

number of available levels	L1	L2	L3	L4	L5	L6	L7	L8	L9	L10	L11	L12	L13	L14	L15	L16	L17	L18
Martin System Red (18 levels)	136	184	376	576	648	648	648	672	728	784	792	792	792	792	792	792	792	792

number of available levels	L1	L2	L5	L10	L15	L20	L25	L30	L35	L40	L45	L50	L55	L60	L65	L70	L75	L80	L90	L100
PE-900 - 100 kOhm				216		352		440		528		592		720		856		1000	1200	1400



Conclusion

After analyzing the results of this test, it is clear that there is a big difference in the electrical signal between the vendors. There are several important parameters in e-collar devices. You have the waveform of the signal, the amount of levels you can apply, the power of the device, the width and the duration of the impulses. The combination of those parameters make it a good or a bad device! Having 100 or 127 levels of stim doesn't mean you have a better e-collar!

E-collar technologies told me that the signal in their products is wide and comparable with a muscle stimulator. Because of what they told me I expected another waveform so I am disappointed in the outcome of the e-collar technologies equipment. For me, the waveform is important and based on what they told me, I bought a PE-900. The PE-900 is not a bad device but the waveform looks like the Dogtra waveform so that difference is too small and it is not what I wanted or expected. I didn't want to buy a new e-collar just to have the same e-collar in a new jacket. It looks like Martin System has the most sophisticated technology, they are also more expensive but maybe there is a reason for that and that is that quality is something that needs to be paid (For your information, I don't own a Martin System e-collar –yet-)! If Martin System would have had detailed papers available on their website and a better explanation about their "constant stimulation sensation" (S.S.C.) and their "new high voltage" (N.H.T.), I might have bought the PT-3000 with finger kick. There is also a lot of marketing chit-chat going on about e-collars and it is not always easy to make the right decision because you rely on the explanation, knowledge and experience of somebody else if you want to buy an e-collar. With this report, you have extra information that can help you make a good and wise choice, in favor of your dog. That doesn't mean that everybody has to buy a particular brand because everybody has his own reasons why he/she should buy a device (good support, looks nice, easy to work with, cheaper, more features, etc…) but remember that if you go cheap, you will end up with crap and that's not good for the dog or the public opinion about e-collars. As a dog trainer and dog lover, I want to train & rehabilitate dogs and make use of the technology to do so. I trained my shelter pitbull with an e-collar –as a tool in my training plan- and he is doing great.

There are also e-collars that I wouldn't use personally and those are the "Chinese internet crap e-collars", "Petsafe 1000". I personally did use the Petsafe for one week when I was new to e-collars but there is too much power and too less levels to work with and you even feel the pinprick in the waveform at L1. With this e-collar you can only say NO to the dog. A good e-collar trainer can use the e-collar as a communication device and that is just not possible with the "Petsafe 1000".

About the Garmin I have a mixed feeling, it has a real AC waveform in the lower levels but it's a device with a lot of power so you need to be cautious with sensitive dogs and/or inexperienced handlers. With the Garmin, I like the fact that they have a different waveform without the pinprick in the lower levels but I would like to see a same waveform in the higher levels and with this amount of power it would be better if there were much more levels on that e-collar (like 100) so you can gradually go up. There is also a bark control feature on that e-collar but I wouldn't use that because for a good bark control device, you have to measure the sound AND the vibrations in the dog's throat.

There is one e-collar that I would have liked to have too for this test and that is the Chamelon®II. The Chamelon®II, designed by Bart & Michael Bellon has Martin System technology under the hood and is improved with another design. You can charge it via induction, has contact feathers and a bungee collar so you really can't compare it with any other e-collar.

So finally, if I have to choose a winner based on the waveform and the quality of the signal, it would be Martin System since they can keep that same stable waveform in the different levels without going high in power and they have the most features (PT 3000). Because of the combination of that stable waveform, most sophisticated signal (they change the width and the height of the amplitude) and advanced features, you have the ability to get the best training results with your dog.

Advise

If you want to train with an e-collar, buy a quality product and pay a good trainer to help you and keep in mind that the e-collar is only a tool in your training plan. First, you need to understand how you need to communicate with your dog and how you need to treat him to establish a rock-solid relationship. Good luck!

Changelog

2016/12/20 Added changelog and “Add-on information”

Add-on information