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Limiters: Theory & Practice Part 2

How they function and how to use them correctly

Introduction

All NST processors[1] feature two stages of limiter protection on all outputs – an RMS limiter designed to control sustained maximum output level (and so manage speaker thermal stress), and a look-ahead clip limiter, designed to prevent over-excursion (and so reduce mechanical failure).

Setting the RMS Limiter Threshold

The following section describes how to set up the units' limiters to provide exceptional protection against driver overheating and cone over-excursion. Most speaker systems are given a power rating in Watts RMS. This is the maximum continuous power that the system will handle and often appears very conservative. In reality, as music program is far from continuous in nature, the peak power of the system is much higher – up to ten times the continuous figure.

Any limiter, which is to protect the driver from damage, must be able to fulfil the following tasks:

- Have an attack time which is calculated to allow transients through but keep the RMS level below the speaker manufacturers specification;
- Have a release time which is sufficiently long to avoid the limiter itself modulating the program;
- Be intelligent enough to adjust the envelope of the limiter according to the frequency content of the program material.

The RMS limiters are capable of performing all these tasks. The only parameter that the user must set manually is the threshold, and it is crucial that this is done correctly. As explained in part 1 of this document, we recommend setting the attack and release times to "Auto" and letting the software calculate these based on the high pass filter setting.

The table below cross references speaker power ratings at various impedances with a corresponding dB value. Using this table, it is a straightforward procedure to work out the required setting of the limiter thresholds for the system.

dB	Ratio	Vrms	Pwr 32Ω	Pwr 16Ω	Pwr 12Ω	Pwr 8Ω	Pwr 4Ω	Pwr 2.7Ω	Pwr 2Ω
45	177.83	137.74	593	1186	1581	2372	4743	7027	9487
44	158.49	122.77	471	942	1256	1884	3768	5882	7536
43	141.25	109.41	374	748	997	1496	2993	4434	5986
42	125.89	97.52	298	595	793	1189	2377	3513	4755
41	112.20	86.91	236	472	629	944	1888	2797	3777
40	100.00	77.46	188	375	500	750.00	1500	2222	3000
39	89.13	69.04	149	298	397	596	1191	1765	2383
38	79.43	61.53	118	236	315	473	946	1042	1893
37	70.79	54.84	94	188	250	375	752	1114	1504
36	63.10	48.87	75	149	199	299	597	885	1194
35	56.23	43.56	59	119	158	237	474	702	949
34	50.12	38.82	47	94	125	188	377	556	754
33	44.67	34.60	38	75	100	150	299	443	599
32	39.81	30.84	30	60	79	119	238	352	475
31	35.48	27.48	24	47	63	94	189	280	378
30	31.62	24.49	19	38	50	75	150	222	300

[1] Original D48 adds clip limiter functionality on outputs in 48kHz mode.

1) Check the RMS power rating of the speaker system, and its impedance.
2) Look up this value in the table above, using the closest value below the rated power of the speaker system. Note the corresponding 'dB' value.
3) Check the gain of your amplifier, which needs to be in 'dB'.
4) Subtract this gain figure FROM that obtained from the table to find the required absolute setting for the limiter thresholds.

   Note that, for safety, always set the limiter threshold 1 or 2 dB below the maximum allowable worked out using the above method.

As an example, for a subwoofer rated at 2000W and 4Ω, working with an amplifier which has 32dB of gain, the limiter threshold would be calculated as follows:

1) Check the RMS power rating of the speaker system, and its impedance. **2000W, 4Ω**
2) Look up this value in the table above, using the closest value below the rated power of the speaker system. Note the corresponding 'dB' value. **41dB**
3) Check the gain of your amplifier, which needs to be in 'dB'. **32dB**
4) Subtract this gain figure FROM that obtained from the table to find the required absolute setting for the limiter thresholds. **41 – 32 = +9dB**

   Note that, for safety, always set the limiter threshold 1 or 2 dB below the maximum allowable worked out using the above method - with safety margin, **+8dB**

Setting the Clip Limiter Threshold

Assuming the RMS limiter has been set correctly and, just as importantly, attack and release times have been chosen as appropriate to the driver to be protected, the clip limiter is typically set to limit overshoot to 3dB above the RMS limiter threshold.

This would allow peaks of twice the RMS power level to reach the outputs. If the driver has a peak power capability of more than double the rated RSM power, then this value can be increased.

To calculate the setting for the clip limiter it's:

10 x (Log10(Peak Power / RMS Power))

So for example, a 15" driver has a quoted RMS power handling of 800W, and a peak power handling of 1600W, the calculation is

(1600/800) = 2
Then Log10(2) = 0.3010
Then 10 x 0.3010 = 3.010 or 3dB

Speaker manufacturers may quote AES power in place of RMS power and "Program" instead of "Peak". These terms, whilst not strictly interchangeable, are similar as a "pair" of measurements. AES tends to be a slightly more conservative rating given the definition of how it is measured.

If AES power is quoted, then it normally is paired with the "Program" rating and so the calculation of the threshold for the clip limiter is still valid.

Setting Appropriate Attack and Release Times

As explained in part 1 of this document, high performance limiters are provided for every processor output with control over attack time, release time and threshold parameters. This level of control allows the user to balance the required subjective quality of the limiter against the driver protection requirements. Be aware that a limiter set incorrectly can sound worse than no limiter at all!

In particular, as with all limiters, using too fast an attack or release time for the type of signal in the pass-band will result in excessive low frequency distortion. There is provision, in the output sections of each processor's configuration within D-Net, to set automatic limiter time constant on an output by output basis. Use this option if you are unsure how to set the time constants manually. We recommend the use of the automatic setting.

In this mode the time constants will be automatically set from the corresponding channel's High-Pass filter frequency according to the table below.

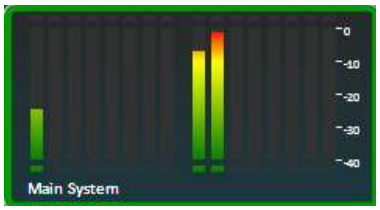
High Pass Filter	Auto Attack Time	Release Time
<10Hz – 31Hz	45mS	x16 (720mS)
31Hz – 63Hz	16mS	x16 (256mS)
63Hz – 125Hz	8mS	x16 (128mS)
125Hz – 250Hz	4mS	x16 (64mS)
250Hz – 500Hz	2mS	x16 (32mS)
500Hz - 1kHz	1mS	x16 (16mS)
1kHz – 2kHz	0.5mS	x16 (8mS)
2kHz – >32kHz	0.3mS	x16 (4mS)

Only the release time may be adjusted for the clip limiters, as attack time is always set to "zero-overshoot" and so cannot be changed. The release time may be set as a factor of the attack time (from x2 to x 32) – we recommend using the automatic setting which is selected for both limiters.

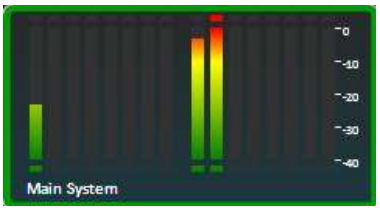
Monitoring Limiters in D-Net

It's not necessary to have a device open for editing to see if there is limiting at work on any output – the system monitor will show this on all channels of all units:

No Limiting



Output 2 at Threshold



Output 2 Limiting

When setting limiter thresholds, be aware that the output meters are referenced to the limiter threshold for that channel, so as the limiter threshold is reduced (so the value is decreased to provide more protection), the meter level will be seen to rise by the corresponding amount.

As the gain control for the output is pre-limiter, adjustment of this will also affect the meter reading. Increasing the gain will naturally bring the signal level closer to the limiter threshold and so the meter will again rise.

The envelope of the metering is also affected by the attack and release settings for the RMS limiter, and adjustment of these will affect how the meter responds.

Output 2 in this case is just over the limiter threshold and the Gain reduction meter which reads downwards above the normal meter, is just starting to register gain reduction.

Outputs 1 & 2 are limiting in the above example and the heavy gain reduction can be seen in the metering (in addition to the level meters being at the end-stops in red!).

Limiters Are A Good Thing

Remember that the limiters only need to be set up once for your system and from then on they will protect against anyone either externally turning things up too much, or from excessive EQ adjustments. Correctly configured, they are a valuable tool in not only making the system sound better at all times, but also ensuring increased reliability of your amps and speakers.

Please be sure to read part 1 of this document to fully appreciate what they can do for you!