

**avantgarde**  
ACOUSTIC

# iTRON

Innovation, that revolutionize the sound.  
The amplifier, that is not an amplifier.

# iTRON.

CURRENT DRIVE – DELIVERING PERFECT CONTROL.

iTRON<sup>AA</sup> is a revolutionary electronic circuit from Avantgarde that, for the first time ever, allows perfect control of the driver's diaphragm, achieving an incredibly detailed, pristine and crystal-clear sound. The difference to conventional amplifiers is so great that we call it our game-changer technology.

iTRON<sup>AA</sup> is based on the current convertor circuit principle. Our patented development is based on the concept of an ideal voltage-current converter being the perfect driver for a dynamic loudspeaker. Innovative, stringent and, above all, electro-physically correct. iTRON<sup>AA</sup> is not an amplifier, but "the most sophisticated driver engine in the world". In order to better understand this logic, we would like to take you on a short excursion into the basics of electro-physics.

## HOW A LOUDSPEAKER WORKS.

A loudspeaker converts electrical energy into acoustic signals (sound). The functional principle is based on current flowing through a coil suspended in a magnetic field. It is important to

understand that the acceleration of the diaphragm is caused by the magnitude of the current flow – and not by the magnitude of the electrical voltage.

## HOW AMPLIFIERS WORK.

Paradoxically, however, practically all commercially available audio amplifiers work on the principle of voltage amplification. This means that an amplified voltage, which varies with and tracks the music signal, is fed to the loudspeakers. Strictly speaking, the voice coil is supplied with the wrong signal – a current flow is needed to generate sound, not a voltage. The fact that this sub-optimal system nevertheless works is due to the electro-physical relationships between voltage, current and resistance.

## OHM'S LAW.

Ohm's law states: the strength of the electric current flowing through an object is proportional to the electric voltage at constant resistance. This means that if the voltage increases at a loudspeaker voice coil with constant impedance (e.g.

8 Ohms), the current flow increases proportionally and the diaphragm is accelerated in a linear fashion, tracking the input signal.

Conversely, Ohm's law also states: for the same voltage, the current flow depends on the resistance. The greater the resistance, the smaller the current flow and vice versa. The diagram below with the water containers illustrates these relationships.

In the case of a real-world loudspeaker, with constantly changing impedance, this means that the diaphragm's acceleration is no longer linear compared to the input signal, introducing significant distortion.

It is therefore crucial to understand the actual impedance characteristics of any loudspeaker.

## OHM'S LAW

$$I = U/R$$

Current                      Voltage                      Resistance

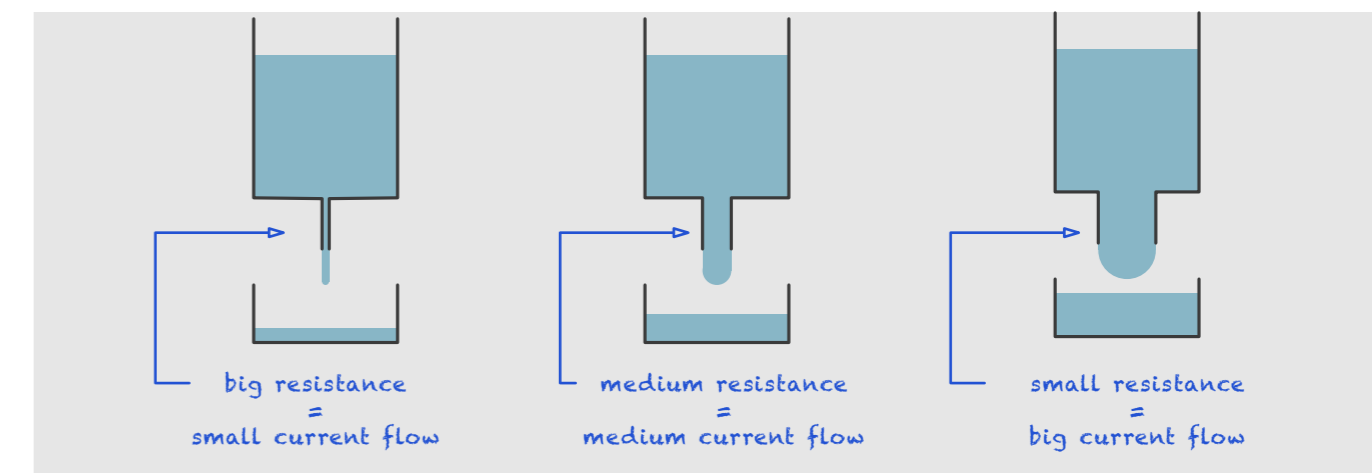


Fig. Water tank with identical water level or pressure (= voltage).

# Loudspeaker impedance.

THE ORIGIN OF THE SINGLE BIGGEST ERROR IN AMPLIFIER DESIGN.

A dynamic loudspeaker is a complex electro-physical system whose resistance, i.e. impedance, is influenced by a multitude of factors. Difficult to control, these factors constantly change during operation.

## FREQUENCY-DEPENDENT IMPEDANCE CURVE.

The impedance curve of any drive unit varies but is highest in the range of its resonant frequency. A voltage amplifier reacts to this changing impedance, reproducing certain frequency ranges too loudly or too softly, distorting the music signal.

## INDUCTIVE REACTANCE OF THE VOICE COIL.

The inductive reactance of the voice coil causes increasing impedance at high frequencies. With a voltage amplifier, this causes a drop in level at higher frequencies, especially with tweeters.

## POSITION-DEPENDENT INDUCTANCE.

The inductance of a voice coil depends on its distance from the pole core. When oscillating in and out, this distance changes and thus automatically changes the electrical inductance. Operated with a voltage amplifier, a driver thus produces

continuous distortion that can be up to 20%, depending on the driver's stroke. Dynamic music impulses are thus distorted.

## BACK EMF.

A voice coil with current flowing through it generates a negative voltage when it swings out, which is fed back into the loudspeaker cable. This so-called counter-electromotive force (back EMF) reduces the incoming voltage, voltage that is actually required for a voltage amplifier to track the music signal. Music impulses are reproduced too softly and dynamics are compressed.

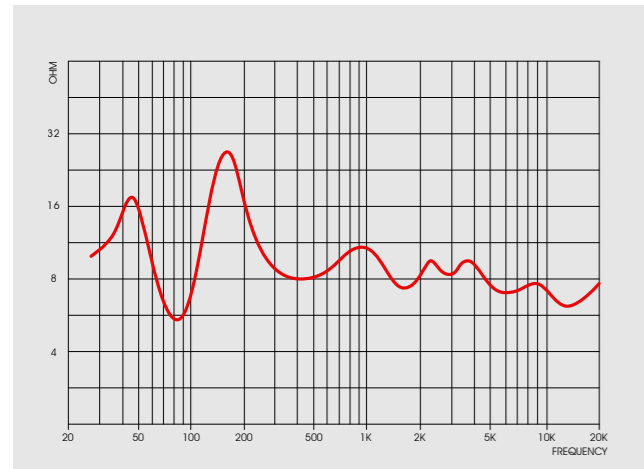
## THERMAL COMPRESSION.

During operation, a voice coil carrying current heats up, sometimes considerably. Heat increases its internal resistance and under full load the impedance of the driver can increase by up to 40%. Musical impulses are strongly compressed and there is a considerable reduction in dynamics.

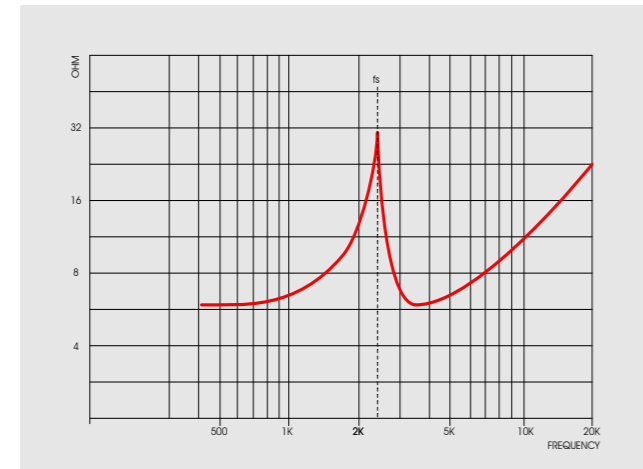
## THE INERTIA OF AN ACCELERATED MASS.

In physics, inertia is the tendency of moving

bodies to remain in their state of motion. In relation to the loudspeaker, Newton's 1st law means that the accelerated diaphragm tries to maintain its direction of movement, independent of the music signal. The magnitude of this force, which directly counteracts the music signal, depends on the moving mass of the driver and the speed of the diaphragm's movement. In practice, this means that loudspeakers with a high moving mass cause considerable non-linearities at high volumes.



Impedance curve of a multi-way loudspeaker



Impedance curve of a tweeter



Fig. Resistor



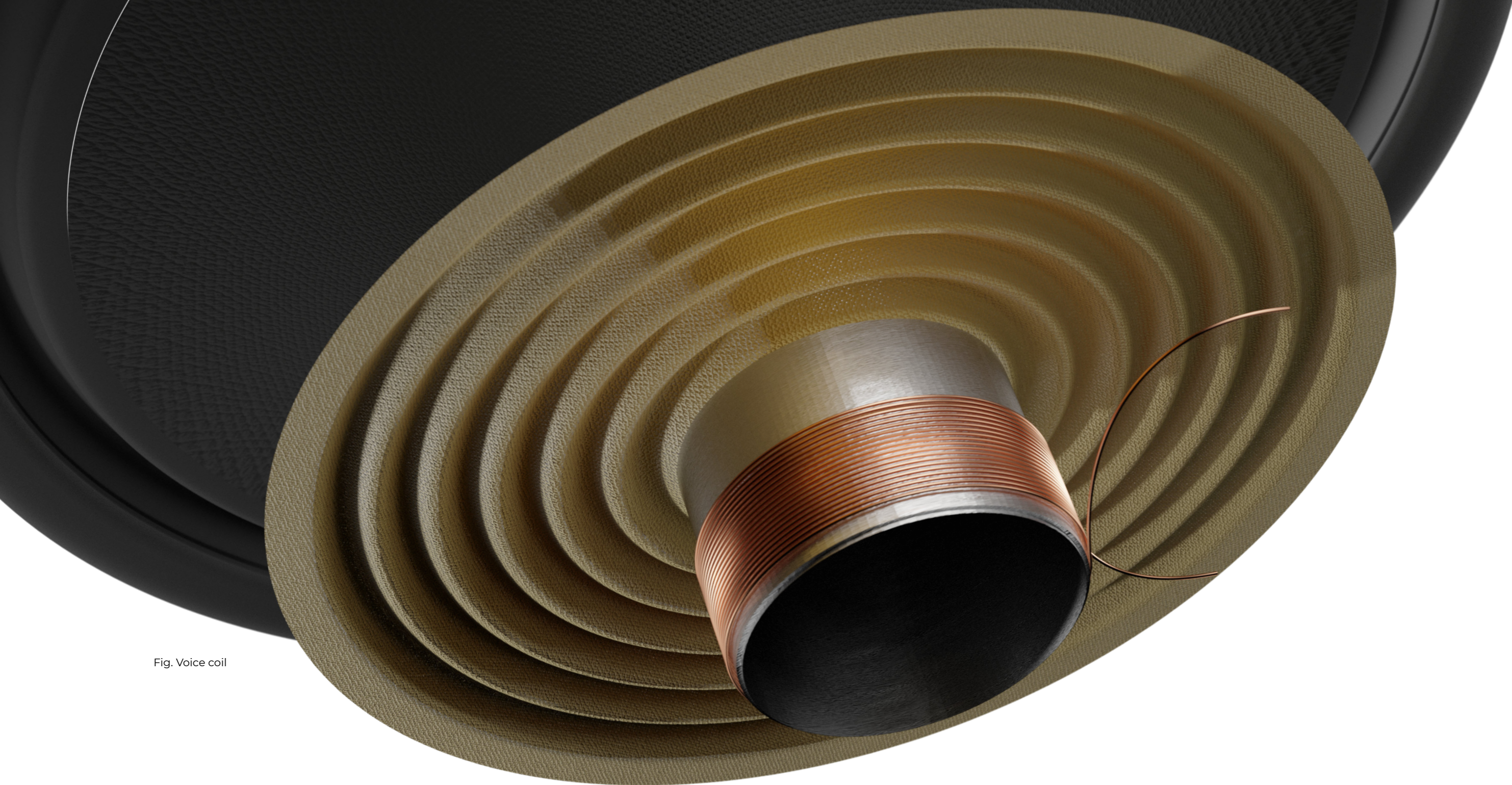


Fig. Voice coil

## The challenges facing current amplification.

OR, WHY CURRENT DRIVE IS NOT COMPATIBLE WITH EVERY LOUDSPEAKER.

As explained in detail, a loudspeaker is an extremely complex load and impossible to operate without distortion, at least with a voltage amplifier. Nevertheless, virtually all, audio amplifiers are based on this principle. Why voltage amplifiers? Why are there practically no current amplifiers on the market? The reasons lie in a basic incompatibility between current drive and conventional passive loudspeaker cabinets and in the enormous complexity of current amplifier technology.

### CURRENT DRIVE RESTRICTIONS.

A current amplifier cannot control a drive unit in the range of its resonant frequency. This is the range at which any loudspeaker is loudest and at the same time has its impedance maximum. The iTRON<sup>AA</sup> circuit would try to compensate for the peak and "pump" ever more energy into this range. The electronics would be overloaded and the loudspeaker would therefore inevitably boom at this frequency.

To further complicate matters, the principle of the current amplifier does not work with passive

cross-overs. Instead of precisely controlling the current flow in the voice coil, parts of the current would flow unhindered through and flood the passive crossover.

So, current drive technology cannot be used in the drivers' resonant frequency range and cannot be used on a passive speaker.

Since practically all loudspeakers are based on these principles, only voltage amplifiers can be used in these applications.

### THE AVANTGARDE WAY.

But we are so convinced of the clear superiority of our iTRON<sup>AA</sup> current drive technology, that we developed a system topology just to exploit it. By moving to a fully active system, in which each individual drive unit has its own iTRON electronics, we can ensure that each driver is operated outside its resonant frequency range and that there are no passive crossover components in the signal path.



# iTRON- the greatest technological challenge.

THE PUREST VOLTAGE-CURRENT CONVERTER EVER.

iTRON<sup>AA</sup> is the greatest technological test we have ever faced. Theoretical knowledge is one thing, but its implementation is the real challenge. As with any fundamental innovation, it demanded extensive basic research.

We developed the most diverse circuit concepts and extensively tested them on the widest range of drivers, with technical measurement and comparative listening, the entire development programme taking over five years. The end result: a patented circuit that outclasses every voltage amplifier known to us and puts all previous current amplifier concepts in the shade.

Established current amplifier circuits work either as a voltage amplifier with a current feedback or as a current amplifier with feedback. In both variants, the negative feedback turned out to be too sluggish for the requirements of a high-end audio amplifier.

The iTRON<sup>AA</sup> circuit, which we have submitted for a patent, is a symmetrical, single-ended circuit

without any negative feedback. The output is a perfectly controlled current that exactly follows the voltage at the input. Strictly speaking, therefore, the iTRON<sup>AA</sup> circuit is not really an amplifier at all, but a sophisticated voltage/current converter, an engine that directly controls movement of the driver diaphragm.

## LABORATORY TESTS.

To demonstrate the dramatic advantages of the iTRON<sup>AA</sup> circuit, we can simulate its behavior compared to a voltage amplifier using laboratory modeling techniques. The two graphs show a

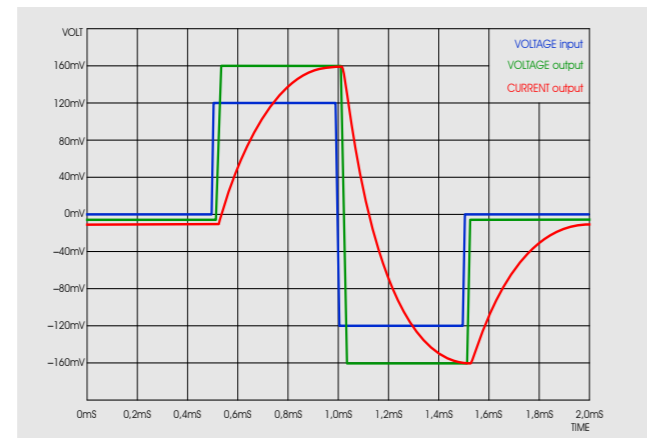


Fig. 1: Voltage amplifier simulation

simulation of both concepts using a 2-way box loudspeaker. The curves for input voltage (blue), output voltage (green) and output current (red) are slightly shifted relative to each other for greater clarity.

With the voltage amplifier (Fig. 1), the input voltage is amplified perfectly to the output voltage. In this circuit, the current (red curve), which actually accelerates the diaphragm, builds up only slowly due to the inductance of the voice coil and runs sluggishly behind the input voltage. Pulses of musical energy are inevitably slowed

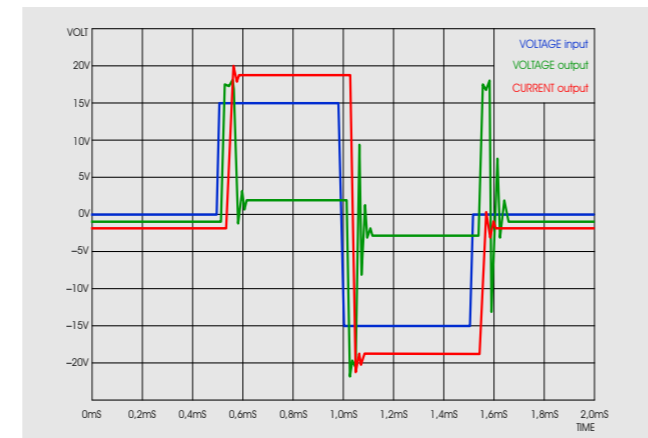


Fig.. 2: iTRON current amplifier simulation

down and reproduced with a time delay.

The simulation of the iTRON<sup>AA</sup> current amplifier (Fig. 2) shows the completely different way in which this circuit functions: the output voltage (green curve) does not follow the input voltage, but peaks dramatically (approx. 20V) at the beginning of the input pulse. The current amplifier circuit thus generates a short max. voltage so that the inductance of the voice coil is overcome and the current starts to flow immediately. In this case, the output voltage peak runs ahead of the output current, but the output current is a time-correct, practically perfect 1:1 copy of the input voltage.

## SUMMARY.

In terms of both operational principle and measured performance, the iTRON<sup>AA</sup> current drive circuit is superior to any voltage amplifier on a compatible loudspeaker. No other amplifier concept is able to drive and control the voice coil so perfectly: innovative, stringent and, above all, electro-physically correct.







## The iTRON Modul.

THE BEST AUDIO CURRENT AMPLIFIER OF ALL TIME.

The iTRON<sup>AA</sup> circuit (patent pend.) combines the innovative direct voice coil drive technology of the current amplifier principle with a state-of-the-art circuit topology of uncompromising high-end technology.

The iTRON<sup>AA</sup> module of the TRIO G3 includes 3 x analog crossovers and 3 x completely autonomous current amplifier circuits.

The active crossovers limit the operating range of the amplifiers to the exact frequency range of the respective driver. This ensures that the current amplifier does not operate within the resonant frequency of the drivers. In the signal path of the circuit we use the superior sounding NatureCap<sup>AA</sup> components. Extremely intricately designed capacitors, handmade in Germany.

The iTRON<sup>AA</sup> circuitry is fully balanced. The circuits operate exactly differentially and any interference that may occur thus neutralizes each other.

The current amplifier is designed as a single-ended amplifier. With this circuit design, the operating current is always larger than the actual music signal and thus has by far the lowest distortion and the purest sound.

The limited slew rate of multiple amplifier stages results in a certain delay time between the input and output signal when using negative feedback. This adds up accumulatively over several amplifier elements and leads to audible sonic degradation. iTRON<sup>AA</sup> is consequently a pure zero-feedback circuit that operates without any negative feedback in the signal path.

The generously dimensioned power is provided by modern power supply technology of the latest generation. All electronics are protected by a state-of-the-art E-Fuse circuit. This is not only faster and thus safer than conventional fuses, but also much better in terms of sound quality.

The iTRON<sup>AA</sup> active module is connected via a balanced XLR input. For the balanced connection to the SpaceHorn, an XLR daisy-chain output is available.

With the power mode switch 4 different power on/off modes can be selected. A 12V trigger input is available for automatic remote power on.

Via GAIN switches the input sensitivity can be adjusted. To avoid sound degrading potentiometers in the signal path, 3 x precision switches in an additive stepped arrangement are used for this purpose.

The volume of the three TRIO horns can be adjusted in adjusted in +/- 1.5dB steps. The settings can be made according to personal taste, to match the sonic "tonality" of the connected source devices or to slightly correct room acoustic influences.



## The place where paradise caresses music.

HORN & CURRENT – THE PERFECT COMBINATION.

The speed and dynamics of our horns combined with the control and resolution of the iTRON<sup>AA</sup> circuitry is an audiophile marriage made in heaven – a perfect combination – a seamless junction between the world of acoustics and the world of electronics. It is the place where paradise caresses music.

What does iTRON<sup>AA</sup> sound like? Fantastic, phenomenal, audibly invisible, unforgettable, beyond our wildest dreams or simply super awesome? We are happy to leave the struggle for an adequate description to you: music – live music – means different things to different people. But we would like to point out a few attributes that distinguish the performance of our iTRON<sup>AA</sup> current drive from that of the very best and most highly regarded voltage amplifiers.





# SUBSTANTIALLY BETTER DYNAMICS.

HORN & CURRENT – THE PERFECT COMBINATION.

iTRON<sup>AA</sup> delivers much wider and more natural dynamics because the impedance fluctuations in the loudspeaker are effectively eliminated, the current output (and thus the acceleration of the diaphragm) perfectly tracking the input signal. The power in the musical performance is unleashed. Like live. Like an audio system on steroids.





## ETHEREAL RESOLUTION AT LOW VOLUMES.

HORN & CURRENT – THE PERFECT COMBINATION.

The iTRON<sup>AA</sup> circuitry is able to compensate perfectly for inductance effects, especially at very low volumes and with the most delicate electrical signals. Even the quietest sounds have a presence and intimacy, delicate texture and attack, dimensionality, tonal shading and luminous harmonics. Even the quietest passages come to life...

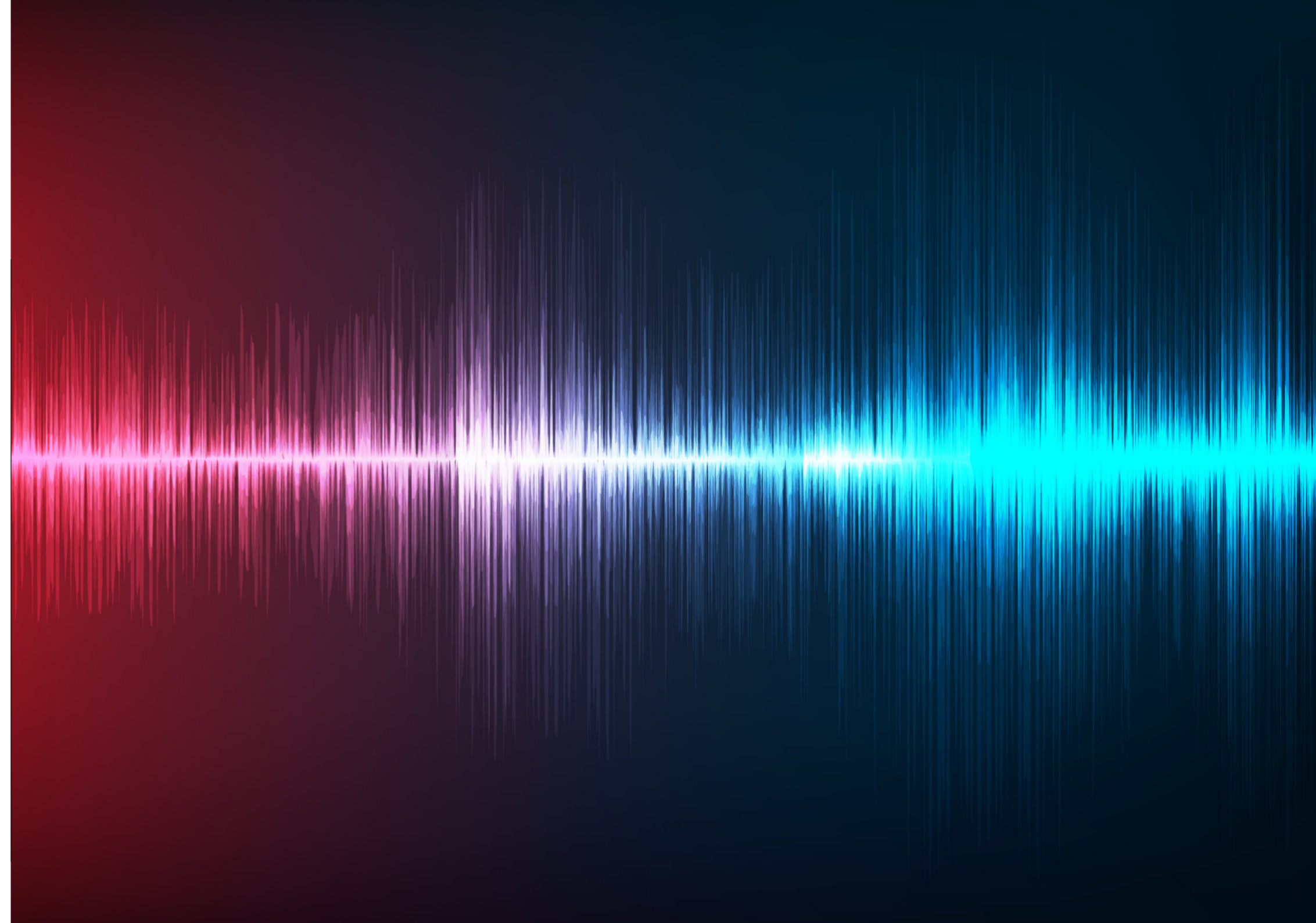




# UNRESTRAINED HIGH FREQUENCIES.

HORN & CURRENT – THE PERFECT COMBINATION.

iTRON<sup>AA</sup> has tremendous high-frequency resolution because it compensates perfectly for the increasing inductance in the tweeter. Combined with the extended frequency response of the new XT3 super-tweeter, this means fabulously delicate reproduction right up to the highest frequencies, without the level drop otherwise inherent in other systems.





## THE MOST PRECISE TIMING THERE IS.

HORN & CURRENT – THE PERFECT COMBINATION.

With the iTRON<sup>AA</sup> circuit, the output current does not lag behind the input signal as it does with a voltage amplifier. Leading edges start at precisely the right moment and rise to exactly the right level. The diaphragm starts to accelerate at the correct time and moves just the right distance.

With iTRON<sup>AA</sup> every detail, every facet of the sound happens in the moment – the right moment.

Temporal accuracy to within one thousandth of a second – separate sounds in perfect harmony.





## EXTRAORDINARY DIMENSIONALITY.

HORN & CURRENT – THE PERFECT COMBINATION.

iTRON<sup>AA</sup> delivers outstanding impulse response from your TRIO G3 loudspeakers (see Fig. 2). Even the smallest time differences in music are reproduced with crystal clarity, recreating the three-dimensional space in which the recording was made, sitting you in the middle of the front row at the live event.





# NO DISTORTION FOR EVEN PURER SOUND.

HORN & CURRENT – THE PERFECT COMBINATION.

Let's cut to the chase: there's no amplifier that sounds anywhere near as natural as iTRON<sup>AA</sup>. The artificial artefacts that bedevil voltage amplification, overlaying, smearing and distorting the musical signal are entirely eliminated. This technology disappears. The sound detaches itself from the loudspeakers, simply existing in your space. The music has a natural clarity and purity – it has the power to touch our heart.







## The place where paradise caresses music.

HORN & CURRENT – THE PERFECT COMBINATION.

As you can see, we are pretty excited. We see iTRON<sup>AA</sup> as a technological step-change, a game-changer that establishes a completely new level of audio and musical performance. Sound that simply sounds like music. Its superiority to conventional technology is so marked that once experienced, you'd rather listen to iTRON<sup>AA</sup> in mono than stereo with a voltage amplifier. Suddenly, eliminating losses in the amplifier/speaker chain means that even an MP3 music file can sound more impressive than the best high-res playback on a conventional system! You probably think that we are exaggerating? Go to your dealer and find

out for yourself. Listen to our iTRON current drive technology on the new TRIO G3. Be sure to compare it with the best voltage amplifiers the market has to offer. More than surprised, you will be shocked. We were ...

Our customers have always been the final judges, our most demanding audience. We have never awaited that judgment with greater confidence.





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