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Review
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HIGH PERFORMANCE FOR THE INSTALLATION SECTOR

Dynacord IPX10:8 Amplifier

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Dynacord IPX10:8

Our test candidate, an eight-channel power amplifier with DSP system and OMNEO interface, promises high performance and provides interfaces for signal transmission and remote control.

With currently four models, Dynacord's IPX amplifier series represents the traditional Straubing manufacturer's highest performance class for the installation market. The three four-channel and one eight-channel amplifiers are equipped with everything that modern amplifier and DSP technology have to offer. The flexible output configuration should be interesting especially for fixed installa-tions, as – additionally to the common 70 and 100 V direct drive and Low-Z operating modes – the series also allows users to operate two or four amplifier channels in bridge, parallel and also in a combined parallel-bridge mode. This means that especially powerhungry loudspeakers and systems can also be powered in 140 V or 200 V systems. In its various operating modes, amplifier channels can be configured from 1,250 W up to 10 kW. IPX power amplifiers are therefore particularly suitable for mixed requirements, for example if some larger loudspeakers need to be controlled with low impedance while, at the same time, 100 V lines are required to power peripheral zones. Further typical applications include line arrays, where many ways have to be supplied and additional, highpower subwoofer amplifier channels are required.

For this article, we tested the IPX series' 10:8 model. The model's name refers to the fact that a total output of 10 kW is distributed over a maximum of eight channels. The other three IPX series models feature four channels and have a total output of 5, 10 or 20 kW. Externally, all amplifiers are identical and are integrated in a solid 2 RU housing with 463 mm rack mounting depth. The device can be operated directly via an OLED display with 256x64 pixels and three buttons or – for the complete range of functions – using IRIS-Net software. As is common for equipment designated for fixed installations, all amplifiers fea-

ture Euroblock (or Phoenix) connectors. Due to the required power, the loudspeaker connectors are relatively large and allow users to connect cables with a crosssection of up to 6 mm².

On the technical side, IPX amplifiers offer a whole range of modern features on all levels. Eco Rail technology ensures that the amplifier requires particularly little power in idle mode or in light load operation ; with its Smart PFC circuit, the power supply unit monitors the amplifier's power supply thanks to its own DSP and adjusts the amplifier's behaviour to the power supply available; and the modern SHARC audio DSP provides al-

DSP SYSTEM AND IRIS-NET

IRIS-Net (Intelligent Remote and Integrated Supervision) is the all-in-one software for the configuration, monitoring and operation of Bosch remote control devices. With IRIS-Net, even large systems can be fully configured and controlled, with the programmer being able to create the corresponding user interfaces and assign access rights. As a consequence, the IPX amplifiers' complete functional range is also accessible via IRIS-Net. The software can be used online as well as offline, so that users can get a good overview of the functions even without having the device at hand.

Once users are connected to a network, the OCA scan tool helps detect all available devices, while the Dante configurator tool can be used to set up the Dante network. The appearance corresponds to that of Audinate's Dante controller. However, users have the advantage of being able to operate directly from the IRIS-Net software.

If users click on the IPX, the first image to appear is the user interface from FIG. 02, which presents an overview of all eight channels. In addition to level displays for inputs and outputs as well as gain reduction, the overview also includes displays for limiter activity, the load monitoring status and the respective channel's temperature. For the power supply, it also features status displays as well as values for the mains voltage and the current currently flowing from the power grid.

If one wants to go into detail, the Set Config button opens another window with seven tabs. To describe its complete content would go far beyond the scope of this article, however, we would like to discuss some important functions. FIG. 03 shows the window for the eight channels' basic settings regarding operating modes bridge, parallel, Low-Z, 100V, ... In the upper part of the window, one can see the basic settings for the sample rate and for securing the power supply.

In the "Speaker" tab, users can load the connected speakers' frequency and phase responses from a library. Using "Load", they can carry out settings for the impedance monitoring as well as a reference measurement, with which later measurements can be compared with during operation. The "Supervision & Test" tab offers a large number of monitoring functions that can be set and monitored.

If users click on the DSP tab, a large block diagram displaying the amplifier's signal processing opens (FIG. 04). For the eight channels, there is a small graphic for each function block, which shows the basic setting, for example a filter curve or a limiter characteristic. A

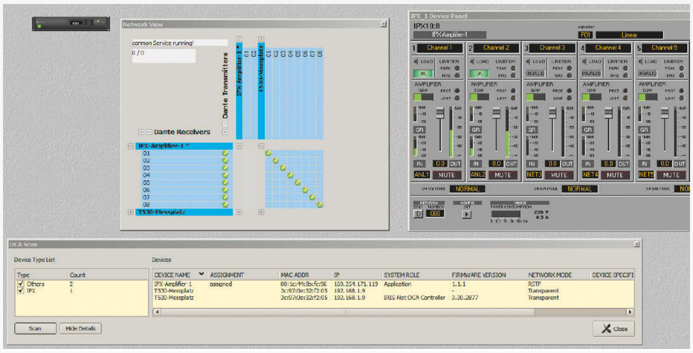

FIG. 01: The IRIS-Net surface with Dante configurator (top left), OCA scan (bottom) and the IPX amplifier's user interface (top right).

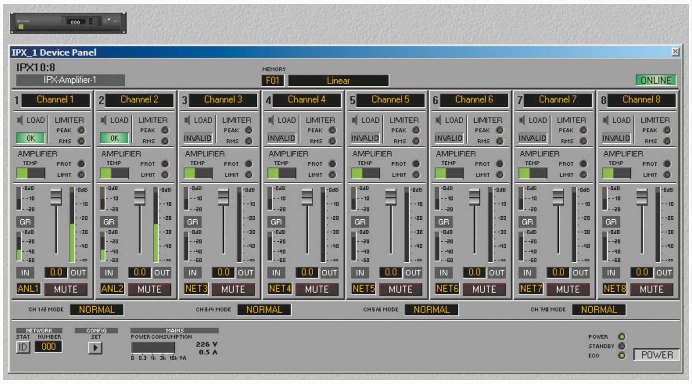

FIG. 02: The IPX10:8's user interface with all eight channels.

FIG. 03: The amp's information and configuration window.

most unlimited possibilities for signal processing and monitoring at a continuous sample rate of 96 kHz.

The universal amplifier: eight channels and loads of power

To ensure a better understanding of the IPX's concept, let us begin with some simple basics regarding amplifier design. An amplifier's capabilities are determined by the maximum output voltage and the maximum output current. Both are primarily determined by the semiconductors used – which in turn are defined by a SOA (safe operation area). While

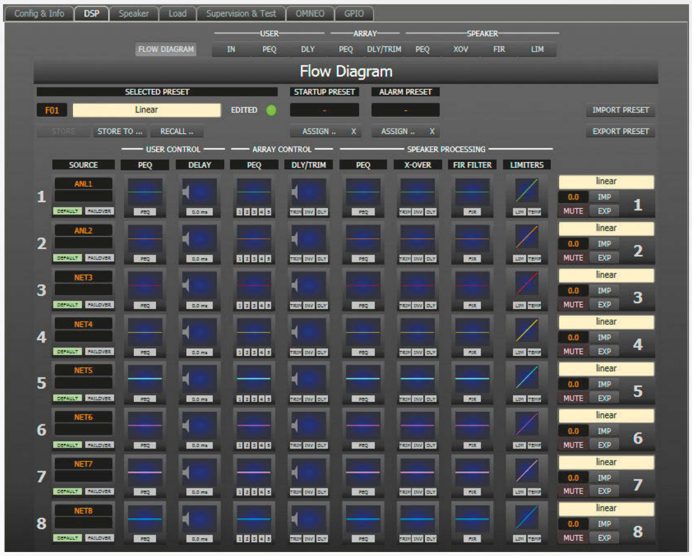

FIG. 04: DSP tab with a block diagram of the signal processing.

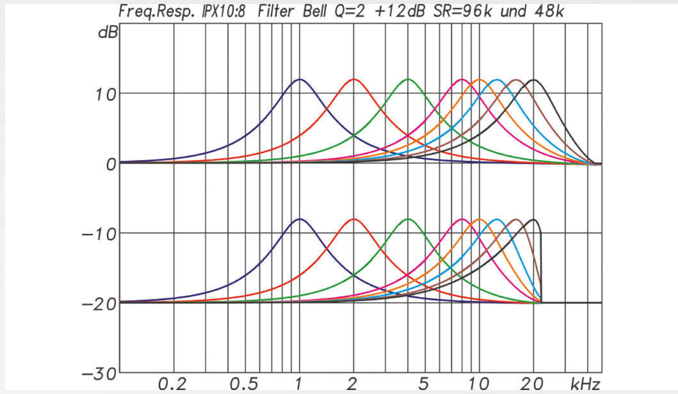

FIG. 05: Parametric Bell filters with Q = 2, Gain = +12 dB and mids from 1 kHz to 20 kHz measured with a sample rate of 96 kHz (top) and 48 kHz (bottom).

click on the graphic opens the corresponding window, where users can carry out the complete settings. The signal flow is subdivided into source selection, user control, array control and speaker processing, with the latter including presets for inhouse Dynacord and EV loudspeakers. Additionally to the usual IIR filters for EQ and X-Over functions, the amp's speaker processing also includes an FIR filter block that can process an FIR filter with 1024 taps at a sample rate of 96 kHz. If a 48 kHz filter set is loaded at a sample rate of 96 kHz, a conversion to 96 kHz is performed automatically. The FIR filters can also be generated as high and low passes using a simple IRIS-Net tool. If users want to use the FIR to equalize the loudspeaker function, this is currently only possible for the inhouse loudspeakers with the prefabricated FIR presents.

All IIR processing filters can be used with 48 and 96 kHz sampling rates. FIG. 05 shows the differences for a simple Bell filter. The curve is compensated depending on the sampling rate, so that the filter function up to approximately 22 kHz always corresponds exactly to the curve of a comparable analogue filter. If this compensation were not calculated, the curves would be compressed with an approximation to half the sampling rate, which would have an effect especially at 48 kHz. The reason for this is the transformation of the filter function from the infinitely extended analogue level to the digital level. The digital frequency axis does not end at infinity but at half the sampling rate, so that by mapping an analogue filter to the digital level (Laplace transformation), the filter curve is compressed at high frequencies and thus distorted in its course. As is the case here, this compression can be avoided by a compensation during the calculation of the filter coefficients. The compensation works until just before the cut-off frequency, which corresponds to half the sampling rate. FIG. 05 shows the filter curves' identical course at 48 and 96 kHz sampling rates up to approximately 22 kHz. At 96 kHz, the process then continues up to 48 kHz, but here without further compensation, as can be seen from the 20 kHz Bell filter, whose right flank differs above 20 kHz in comparison to the left flank below 20 kHz. Twelve IIR filters per channel can be found in the User tab, five in the Array tab and a further ten in Speaker Processing. The IIR X-Over filters can be defined for all known characteristics with slopes up to a maximum of 48 dB/Oct.

All functions for monitoring the amplifier and the connected loudspeakers as well as the pilot tone monitoring and forwarding of the amplifier status can be found in the Supervision & Test tab. The three GPIO ports' functions can be set in detail in the corresponding GPIO tab. Overall, the SHARC 4th Generation processor based DSP system is probably one of the most powerful in an amplifier with DSP. In spite of the great variety of functions, the developers have succeeded in creating a very clear and immediately intuitive user interface that is second to none. Those readers who would like to get a first impression, can download the IRIS-Net software (currently version 4.0.0) free of charge from the Dynacord website.

the maximum allowable voltage is a fixed value, the maximum allowable current also depends on the temperature of the semiconductor. The warmer this component gets, the less power it can cope with. This relation can be accounted for by using a simple hard current limiter with a fixed value in the protection circuit or – as is the case for the IPX amplifiers – by integrating an "intelligent" circuit, the socalled Junction Temperature Modelling (JTM). The JTM always optimally adjusts the current limitation in relation to the currently measured temperature so that the entire SOA can be optimally used. Another limiting factor in an amplifier is the

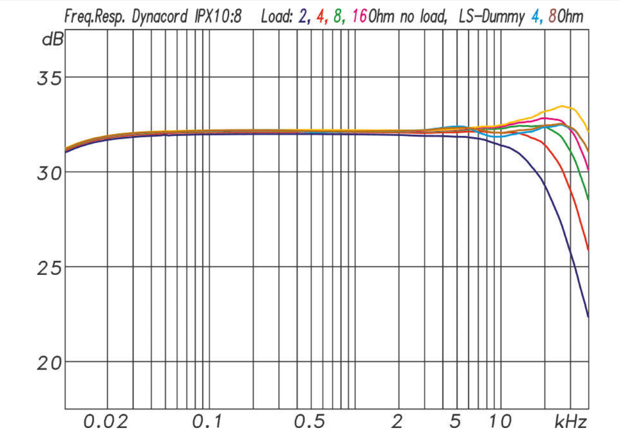

FIG. 06: Frequency response with 2, 4, 8 and 16 Ω loads, without load and with 4 or 8 Ω loudspeaker dummy loads.

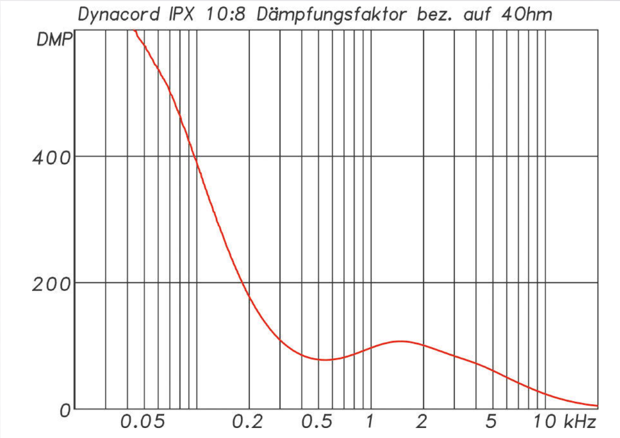

ABB. 07: Damping factor related to a 4-Ω load. Illustrated for channel 1. At 1 kHz, the damping factor is 100. In the important low frequency range below 200 Hz, values of 200 and more are reached.

power supply unit, which needs to provide sufficient voltage and current. If several amplifiers share one power supply unit, the power can be distributed cleverly: when one channel requires only a small amount of power, then more is available for a different channel.

The question now is how much current and voltage are needed. According to Ohm's law, speakers with low impedance, such as 4 Ω or 2 Ω, need a lot of current. If, on the other hand, the loudspeaker has a rather high impedance of 8 Ω or 16 Ω, then high voltage is required. It would therefore be desirable if an amplifier could adapt as well as possible to these different requirements. The precondition for this is a high maximum output voltage in combination with safe current limitation and flexible power supply.

In addition to the socalled Low-Z loads (2, 4, 8 or 16 Ω), 70 V (US) or 100 V lines are also widely used in fixed installations, especially when a lot of loudspeakers are installed in extensive premises. Here, all sources (amplifiers) and sinks (loudspeakers) are defined in such a way that they reach their nominal power at 70 or 100 V (effective value). On the loudspeaker side as well as with amplifiers with low and medium power, this is usually ensured with the help of transformers.

With IPX amplifiers, as is the case for various other models of this power class, the transformer can be dispensed with, as every individual channel is already capable of feeding a 100 V system in the socalled direct drive mode with a maximum output voltage of 150 V_{pk}. The maximum output current of the IPX10:8 model we tested is 41 A_{pk}. Even with a 4-Ω load, the power amplifier would not reach its limit. If current Ω und/or voltage are still not enough, two channels can be bridged (double voltage) or connected in parallel (double current). This way, even rather rare 200 V systems could be powered directly. Such a 200 V system could be found for example in the Moscow Luzhniki stadium before its reconstruction in 2018 – where cables from the amplifier control room to the loudspeakers had a length of over 300 m.

If an amplifier operates in bridge mode, then theoretically it can achieve double the output voltage – an operation, which also results in a correspondingly high current. In bridge mode, the IPX10:8 can deliver an output voltage of up to 300 V_{pk}. With a load of 4 Ω, this would mean a peak current of 75 A_{pk} – something a single channel could no longer deliver. This rather rare case is a case of the parallel bridge mode.

Here, two amplifiers each operate in parallel are then bridged – delivering a peak current of 82 A_{pk}. What sounds simple at first is in fact a major challenge in terms of circuitry. Lowimpedance sources operated in parallel can lead to equalisation currents, which can strongly load or even destroy the amplifiers. Parallel bridge operation is therefore only mastered by few devices and manufacturers.

OMNEO, Dante, OCA, AES70, …

IPX power amplifiers are equipped with two OMNEO network interfaces, which not only transmit the audio signal in a Dante audio network format and but additionally also transmit the parameters for remote control and device monitoring. OMNEO was jointly developed by Bosch and Australian manufacturer Audinate and presented in 2012. The objective was to transmit both the media channel in the Dante format and the system control component in OCA (Open Control Architecture) format using a standard Ethernet connection. Dante is an audio network that is widely used throughout the world. It uses normal network technology, is easy to configure and can be easily integrated into existing network architectures. Almost all manufacturers of digital audio devices today have either already integrated native Dante interfaces into their devices or offer them as an optional supplement. OCA might not be quite as well known, however the standard for control parameters is now also defined in the AES70 standard. It can be operated in parallel to various media channels in a given

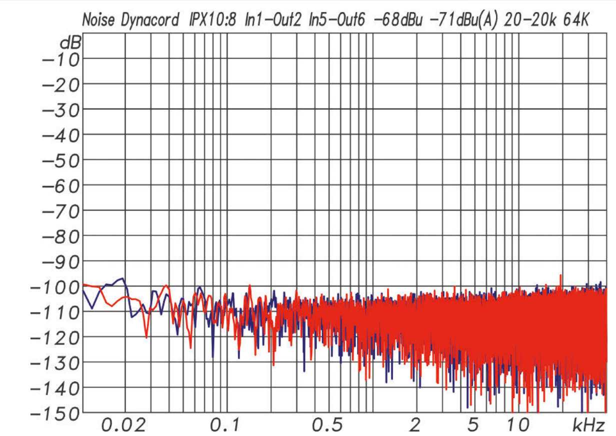

ABB. 08: Signal-to-noise ratio for two exemplary channels at the output when using the analogue inputs. Total level –68 dBu and 71 dBu(A) respectively.

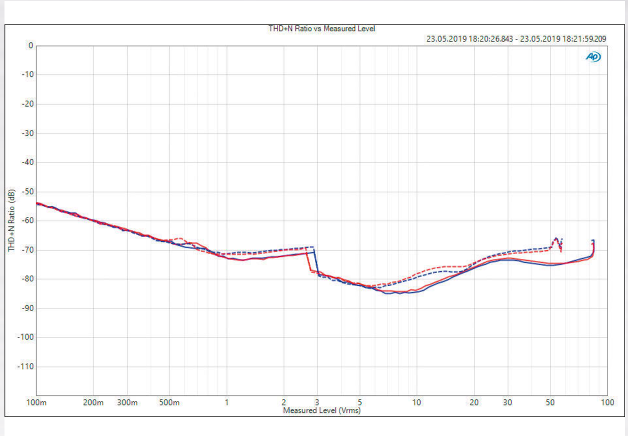

ABB. 09: Distortion factor (THD+N) at 1 kHz with 8 Ω (solid line) and 4 Ω (--) load depending on the output voltage (x-axis). The small jump at 3 V occurs when switching from normal operating mode back to eco mode.

network, such as Dante, AVB, Cobranet and more, and the OMNEO ports can be used redundantly as primary and secondary ports or as switches for daisy chaining. Users can configure their Dante network either by using Audinate's Dante controller software or by relying on a Dante controller, which is integrated in the IRIS-Net software. With their OMNEO interfaces, devices from Bosch can exchange both media signals and peripheral control parameters with devices from other manufacturers using standard IP-based Ethernet connections. As the necessary infrastructure already exists in a lot of buildings, the OMNEO network can build on this – a fact, which in turn can contribute to a considerable reduction in costs. The network load caused by audio data is comparatively low, considering that 64 audio channels with 48 kHz sample rate and 24-bit resolution only produce an 8% load on a 1 GBit network. Separate networks are not necessary for this. For security reasons, IT experts are even increasingly recommending that audio devices be integrated into existing networks, as everything then happens under IT control and the devices are monitored and protected accordingly. Currently, OMNEO devices do not yet support encrypted transmission and do not check the authenticity of the accessing Dante or OCA controller software.

Frequency response and damping factor

Additionally to an amplifier's power, which we will discuss later, values for the frequency response, damping factor and signal-to-noise ratio as well as the distortion values are also important.

Due to a Class-D amplifier's circuit concept with passive lowpass filters in the outputs, the frequency response at the upper end of the transmission range fluctuates to a greater or lesser extent depending on the load. FIG. 06 shows the measurements on the IPX10:8 for purely resistive loads of 2, 4, 8 and 16 Ω as well as with loudspeaker dummies for 4 and 8 Ω nominal impedance and with open output. Apart from the extreme case of 2 Ω, the resulting fluctuations up to 10 kHz lie within a range of ±0.3 dB maximum. With a 4-Ω load, the level at 20 kHz has dropped by just 0.5 dB. Results of this magnitude are entirely unproblematic. If, for comparison, one takes a look at the curves measured with the loudspeaker dummies, the drop in treble is completely compensated for anyway by the impedance, which typically rises to high frequencies with loudspeakers.

In other words, the level loss at high frequencies could also be defined by the amplifier's frequency-dependent internal resistance. If the source's internal resistance is then related to the load impedance, this becomes the wellknown damping factor. FIG. 07 shows how the IPX10:8's damping factor relates to the frequency at 4 Ω. Very high values are achieved at low frequencies; below 200 Hz, rising from approximately 200 at the beginning to over 600. In the mid-frequency range, this results in approximately 100. The curve then drops towards the high frequencies, so that a damping factor of 25 is achieved at 10 kHz. A high damping factor is especially important at low frequencies, where the loudspeaker needs good control by the amplifier to ensure that it does not oscillate too long. In practice, however, values of 100 for the power amplifier are already more than sufficient, as cable and contact resistances usually result in even greater resistances on the signal path anyway. These in turn make it possible to effectively measure a damping factor of more than 25 at the loudspeaker only with short cables and ideal connectors.

Signal-to-noise ratio

Let us now have a look at the next important measured value of an amplifier, the dynamic range. For the calculation, we first need to determine the maximum output voltage. In the case of the IPX10:8, this is around 44 dBu. On the other hand, there is the noise level to be measured at the outputs, which we measured once using the analogue inputs and once

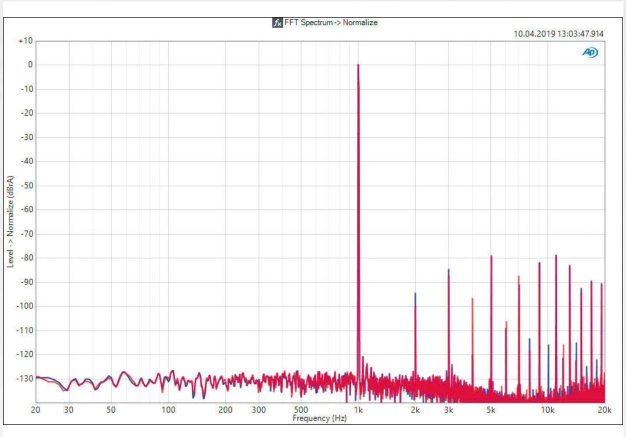

ABB. 10: Output signal as a spectrum at 1 kHz with 8 Ω load and 600 W per channel.

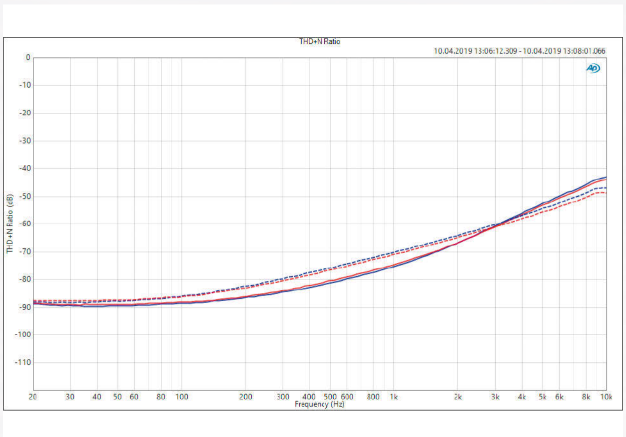

ABB. 11: Distortion factor (THD+N) with 8 Ω (solid line) and 4 Ω (--) load depending on frequency at 300 W per channel (x-axis).

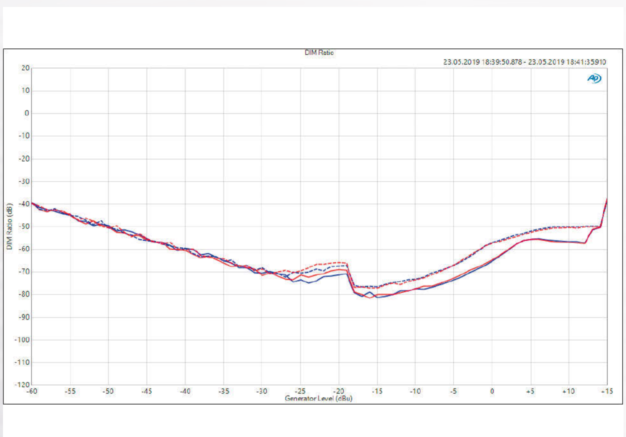

ABB. 12: DIM measurement with 8 Ω (solid line) and 4 Ω (--) load (CH2, CH6) depending on the input level (x-axis).

using Dante. For this purpose, the analogue inputs were connected to a 200-**Ω** resistor. The noise level measured in this way was –68 dBu unweighted and –71 dBu Aweighted. After switching to a digital signal feed, the results improved by 3 dB. Based on the Aweighted noise level, a signal-to-noise ratio of 115 dB is achieved with an analogue feed or 118 dB with a signal feed via the Dante network. The corresponding interference spectra from FIG. 08 show an evenly distributed white noise without any monofrequency components.

Distortion measurements

Which distortion measurements are meaningful for amplifiers and which results should be achieved? And, are they relevant at all, since the following loudspeakers usually produce distortions many times over? These questions have been an issue to audiophile circles for quite some time. If one takes a closer look, one notices that loudspeakers primarily produce 2nd and 3rd order harmonic distortions. However, distortions caused by amplifiers often also contain distortion components of a higher order, which are less well concealed in the audio impression and can therefore be noticed more easily. Classical Class-AB amplifiers already come quite close to the ideal of rapidly decreasing distortion components towards a higher order. Class-D circuits, however, are rather unfavourable in their behaviour and often generate a lot of higher-order distortion components. There are therefore several aspects that need to be considered: the absolute distortion value, their spectral composition and the curve depending on the frequency.

FIG. 09 shows a first series of measurements with THD+N values as a function of the output voltage for a load of 8 **Ω** and 4 **Ω**, exemplarily shown for two of the IPX10:8's eight channels. The results lie between –70 and –80 dB (0.01%) and are thus already in regions that actually do not require any further discussion and can compete with many Class AB or Class H amplifiers. A recently measured, very popular studio technology amplifier also lies within this range. The small jump at 3 V occurs when switching from normal operating mode to eco mode. This series of measurements was carried out in steps from a high level to lower values. If the measurement is reversed, the jump takes place at a higher output voltage, namely where the switch from eco mode to normal operation takes place.

If one has a look at the distortion spectrum in FIG. 10, all harmonics – when looked at individually – are at or below the –80 dB line. The even-numbered harmonics (k2, k4, ...) also show the desired falling tendency. The odd-numbered harmonics present themselves in a little less favourable way. However, it is questionable, to what extent this can still be relevant here. It should also be mentioned that the distortion spectrum is completely free of hum components thanks to the switched-mode power supply.

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When it comes to the power measurements of amplifiers, it makes sense to first think briefly about what happens in a power amplifier and what the limiting factors are. If an audio signal is to be amplified, this can be achieved up to the amplifier'soperating limit. This level limit is determined by the supply voltage provided by the power supply unit – which should therefore be sufficiently high – but of course must not exceed the semiconductors' dielectric strength. A second aspect comes into play, as the supply voltage level also has a direct influence on the amplifier's power loss. Classic Class-AB power amplifiers can therefore be supplied with a multistage voltage or with a voltage that is regulated according to the currently required voltage (this is then called Class-H or Class-G). Dynacord has adapted this technology to Class-D power amplifiers: the amplifier initially runs on a low supply voltage, which is then increased if necessary. This technology from Dynacord, known as Eco Rail, saves up to 50% of overall energy consumption. The result is a significant reduction in operating costs, especially when it comes to installation amplifiers and their continuous operation.

In addition to the maximum possible voltage, depending on the load impedance, the current comes into play. As already mentioned at the beginning, JTM technology ensures that the current is never dangerously high, but is not limited too early either.

Another limiting element is the power supply, which can provide a certain maximum power. If several amplifiers share the same power supply unit, this has to be taken into consideration. With low weight and volume, modern switched-mode power supplies can deliver very high outputs, so that the power supply seldom limits performance. Rather, the problem is the power grid, which is typically designed for 16 A or 32 A maximum current, depending on the type of power supply and the corresponding fuse in the 230 V system. IPX amplifiers are already equipped with a 32 A Powercon socket for the mains connection, so that – with a corresponding cable (3x 4 mm²) and a 32 A CEE plug on the other side – a "real" 32 A connection is also possible. If a 16 A connection is the only connection available, a fuse protection between 6 and 32 A can be set via the amplifier's breaker setting. When making the settings, one has to consider whether several devices are sharing one supply line. Based on typical fuse characteristics, the power supply's DSP calculates which current can be drawn from the grid for how long. During the measurements for this test, the current consumed in the 32 A setting was always only 32 A for a few seconds, after which the power supply limited it to approximately 19 A. With a 32 A connection, the amplifier can therefore definitely be fully utilised. A 16 A automatic circuit breaker with C characteristic would also permit the short 32 A time span and would trigger at a continuous current of 19 A only after a very long time. The IPX20:4, whose power supply has a much more powerful design, is likely to be more critical.

However, in practice, the topic is not so critical anyway, as the average power consumption for a typical music signal with a crest factor of 12 dB or more is much lower. If all of the IPX10:8's eight channels are fully loaded with a 12 dB crest factor test signal at 8 Ω loads, the average power consumption is approximately 2100 W. Depending on the type of signal, the value may vary slightly. However, even with a 4 Ω load on all channels and full modulation, one still remains within the limits of what a 230 V/16 A connection can deliver on a permanent basis.

An amplifier's power measurements are a much-discussed topic. How are they measured? Under what conditions? How are the values ultimately to be interpreted? And what do they mean for practice?

Our output power lab measurements cover all versions of an amplifier's load. In order to be comparable with the manufacturer data, we carry out a series of different measurements according to different standards for all possible load cases from 2 Ω (if permissible) to 8 Ω. The following values are determined in detail:

– the pulse power for a 1 ms single period of a 1 kHz sinusoidal signal

– the sine power for a constant 1 kHz sine signal after one second, after ten seconds and after one minute

– the power for a constant noise level of 12 dB crest factor after ten seconds, after one minute and after six minutes

– the power for a constant noise level of 6 dB crest factor after ten seconds, after one minute and after six minutes

– the power according to EIAJ measured with a pulsed 1 kHz sinusoidal signal of 8 ms duration every 40 ms. The signal has a crest factor of 10 dB

– the power according to CEA 2006 with a 1 kHz sinusoidal signal whose level undergoes a level jump of +20 dB every 500 ms for 20 ms. The signal has a crest factor of 16 dB

– the power for a periodically repeating 1 kHz burst of 33 ms length followed by a 66 ms rest phase. The crest factor of this signal is 7.8 dB

– the power for a periodically repeating 40 Hz burst of 825 ms length followed by a 1650 ms rest phase. The crest factor of this signal is also 7.8 dB

Evaluation is easy for the sinusoidal signals. One notes the effective value and uses it to calculate the power. The sine wave should not yet be visibly distorted. Two values can be determined for the sine burst signals according to EIAJ or CEA. On the one hand, the shortterm RMS value during the duration of the burst and the overall RMS value which includes the signal pauses. The ratio of the two values is 7 dB for the EIAJ signal and 13 dB for the CEA signal. The crest factor,

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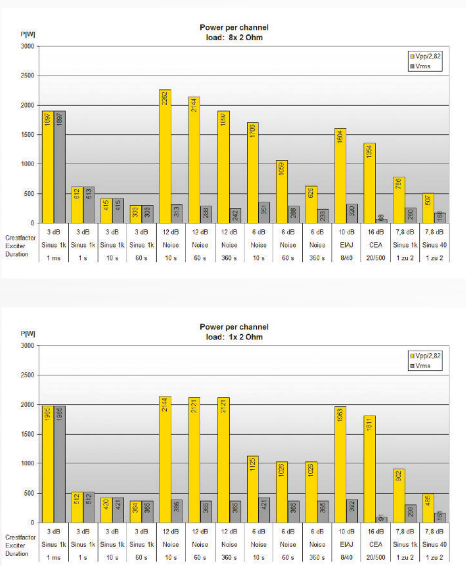
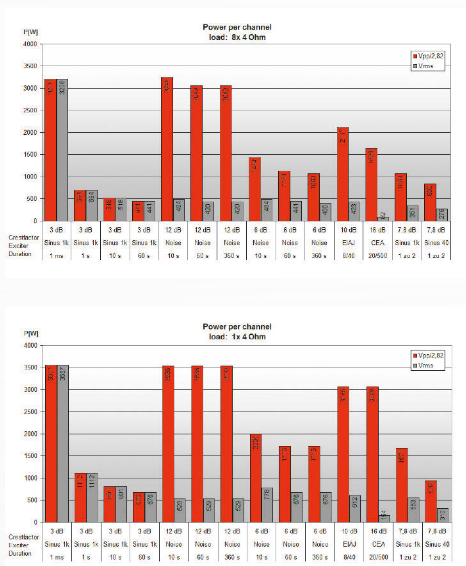
which describes the ratio of the peak value in the burst to the overall RMS value, is 3 dB higher and thus 10 dB and 16 dB respectively. For the burst measurement methods, the power value, calculated from the burst's shortterm RMS, and the overall RMS are specified in the overview. A further burst measurement method operates with 33 ms long 1 kHz bursts followed by rest phases with a length of 66 ms. Here, the crest factor is 7.8 dB. Based on this measurement, the burst frequency was reduced by a factor of 25 to 40 Hz and the time span was extended accordingly by a factor of 25 in order to examine the amplifier's capabilities regarding bass reproduction, where sound is often present for longer periods of time.

It cannot be generalised which burst measurements are better or more meaningful. However, it is important to compare only those measurements that are based on the same measurement method.

The measurement with noise signals with a crest factor of 12 or 6 dB is somewhat different. With these signals, the amplifier is driven up to its clip limit and then permanently loaded. The signal's peak-to-peak (Vpp) and the effective value (Vrms) are then measured after ten seconds, after one minute and after six minutes. As is the case for the burst measurement, from this, a power value is calculated based on the voltage's effective value and a power value is calculated based on the peak-to-peak value divided by 2.82. The results are thus comparable with the burst measurements.

Let us come to the IPX10:8's results: the diagrams in FIG. 13 to FIG. 15 show some important parameters. The maximum power supply output is approximately 4 kW, which is distributed evenly over all eight channels under load. At 8 Ω, 500 W can be delivered permanently per channel. At 4 Ω, this drops slightly to 400 W and to 230 W at 2 Ω. At the lower impedances, the currents are higher and the power supply's current limitation has a limiting effect. The measurements for one channel respectively indicate where the amplifiers have their continuous power limit. Nearly 900 W are reached at 8 Ω, 680 W at 4 Ω and 365 W at 2 Ω. If one takes the pulse power, the value for a signal with a crest factor of 12 dB and the sine power after 10 s each for a load of 8x 4 Ω as the most important values, then this results in a 3208 W pulse power for the IPX10:8, 3049 W for a signal with a crest factor of 12 dB and 518 W sine power per channel. The values in the IPX10:8's data sheet were measured with a 20 ms +20 dB burst every 500 ms, which corresponds to the measurement according to CEA from the diagrams. The data sheet values were met during our measurements within the usual scope of measurement accuracy at 2 Ω and 8 Ω and exceeded at 4 Ω.





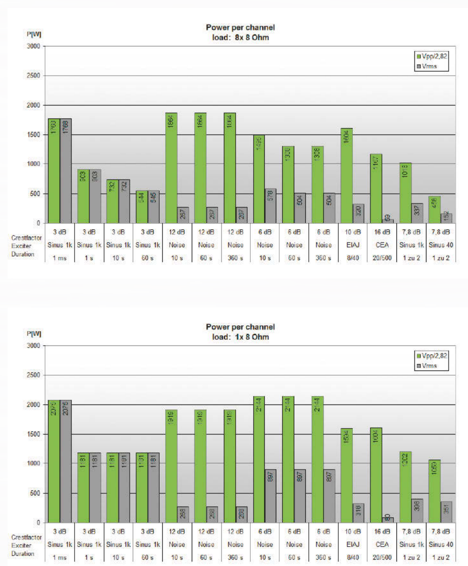


ABB. 13: Performance values at 2 Ω with simultaneous loading of all channels (upper graphic) and loading of only one channel (lower graphic)

ABB. 14: Performance values at 4 Ω with simultaneous loading of all channels (upper graphic) and loading of only one channel (lower graphic)

ABB. 15: Performance values at 8 Ω with simultaneous loading of all channels (upper graphic) and loading of only one channel (lower graphic)

The further THD curves from FIG. 11 were measured with a constant level depending on the frequency. The total of four curves show the two IPX10:8's exemplary channels at 4 Ω and at 8 Ω loads. At 1 kHz, we can find the familiar values from FIG. 09 again. The distortion values fall towards lower frequencies, while rising evenly towards higher frequencies. In principle, this behaviour can be observed with all amplifiers and is caused by the loop gain or negative feedback, which decreases at high frequencies. With Class-D amplifiers, this effect is somewhat more pronounced than with conventional Class-AB amplifiers.

Our final distortion measurement is the DIM (Dynamic Intermodulation Distortion) measurement from FIG. 12, for which a 15 kHz sinusoidal wave with a steep-edged 3.15 kHz square wave was superimposed. The resulting intermodulation products are evaluated as this measurement reveals weaknesses in fast transient signals. The rectangular share's steep flanks are a lot more demanding for the amplifier than the THD measurement's sinusoidal signal. The DIM measurement is therefore more important for an amplifier's audio qualities. The IPX10:8's DIM values lie between –50 and –80 dB and thus in a range which is – in any case – sufficient and can also be described as good for a Class-D amplifier.

Network load

For high-power amplifiers, the load on the electricity grid is an important issue. Directly or indirectly related to this are installation costs, operating costs and ultimately also operational safety. Three aspects play a role here:

1. Efficiency

Efficiency is all about providing as much power for the loudspeakers as possible without generating a great deal of heat loss.
High efficiency reduces direct electricity consumption from the grid and indirectly saves electricity when external cooling is used, as this then has to absorb less waste heat.

FIG. 16 shows the amplifier's efficiency using two curves. The blue curve sets the output power in relation to the total active power consumed from the power grid. Together with the base load, this results

OVERVIEW: DYNACORD / IPX10:8

Performance 8 channels loaded	**Sinus 10 s**	**12 dB CF 60 s**	**Peak 1 ms**
W per ch at 4 Ω	518	3049	3208
W per ch at 8 Ω	732	1864	1768
Noise	**dBu**	**dBu(A)**	
analogue input	–68	–71	
Dante input	–71	–74	
Dynamic	**dB**	**dB(A)**	
analogue input	112	115	
Dante input	115	118	
f[Hz] (load 4Ω)	**20**	**1 k**	**20 k**
Gain dB	31,8	32,1	31,4
Phase °	20°	0°	–40°
HP filter	5 Hz		
TP filter	30 kHz		
f[Hz]	**100**	**1 k**	**10 k**
CTC dB	87	87	62
CMRR dB	77	77	73
DF rel. 4Ω	390	105	25
THD(f) @ 300 W 8 Ω	–90	–75	–42
	Min.	**before clip**	
THD 1kHz	–83	–73	
DIM100	–81	–58	
Power consumption			
Standby	18 W		
No signal	100 W		
Full power	2100 W @ 8x 8 Ω at 12dB CF		
Weight in kg	16,8		
Height RU	2		
RRP incl. tax	6,990 €		
Firmware	IPX10:8 V 1.1		
Power supply	Switching power supply with Smart PFC		
Circuit	Class-D with Eco Rail technology		
DSP System	4th Generation SHARC		
Remote	IRIS-Net via OMNEO		

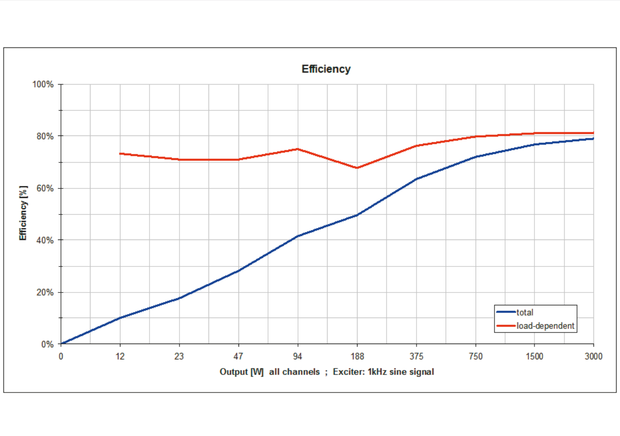


ABB. 16: Amp efficiency in % as a function of the power output (x-axis). In red, the curve without base load showing the amplifier's very good efficiency.

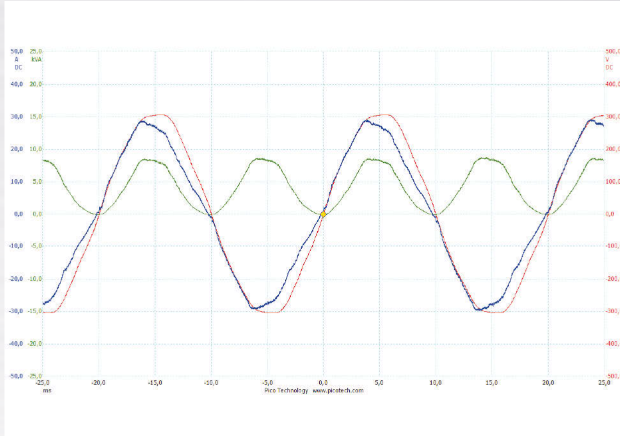


ABB. 17: The course of mains voltage (red), mains current (blue) and the calculated power consumption (green) with an RMS value of 4220 VA.

in rather low efficiency values at low output power. For the red curve, therefore, the output power is only set in relation to the power consumed in addition to the base load. The IPX10:8 demonstrates a good efficiency of slightly more than 80%.

2. The course of the mains current

The current drawn from the grid should follow the voltage in its course as far as possible and the amplifier should thus behave in a manner comparable to a real resistance as a load for the grid. Deviations are caused by displacement reactive currents (capacitive or inductive) and by distortion reactive currents (upper wave component). How well the current curve approaches the voltage curve is expressed using the power factor (PF). FIG. 17 shows the IPX10:8's measurement at full load. Apart from a slight offset and some distortion of the curve shape, the current curve (blue) follows the voltage curve (red) very well. The power factor is 0.99. Such a value is achieved by an active processor-controlled PFC circuit (Power Factor Correction).

In addition to the almost ideal current consumption curve, another advantage of Dynacord's Smart PFC circuit is the precise monitoring and control of the current consumption, which reliably prevents an overloading of the power grid and thus triggering of the circuit breaker.

3. The base load

The third relevant benchmark value when it comes to the subject of grid load is the already mentioned base load or idle power consumption. This value is always important when devices are permanently operated, as is the case in many fixed installations. The IPX10:8's mains power consumption in idle mode is approximately 100 W, which is reduced to 18 W in standby mode. The standby mode can be activated or deactivated either on the device itself or remotely via IRIS-Net software.

Summary

With the IPX series, Dynacord presents four installation amplifiers that set standards in many respects. The four- and eight-channel models feature all conceivable operating modes including bridge, parallel and even parallel-bridge operation and are therefore suitable for all applications with outputs from 1.25 kW to 10 kW. Additionally, even loudspeaker lines with 70, 100, 140 V and 200 V can be amplified without any problems. More flexibility is hardly possible. Another impressive aspect is the amplifiers' absolute stability, which – almost no matter what you do to them – always offer the maximum of what is possible and are stable in operation. With Smart PFC, fuse simulation and Eco mode, the power grid is also optimally used. In addition to their actual function as amplifiers, the IPX models also feature DSP with OMNEO interfaces. Their range of functions is impressive and includes everything one needs for the safe operation of speakers. However, a multitude of DSP functions is only one side of the story. The other is: The developers have also succeeded in designing the ampliers' operation within the framework of the proven and wellknown IRIS-Net software in such a way that setting and operation are intuitive and safe. The corresponding IRIS-Net manual is needed only in rare cases and for some special functions, whereby the manual itself can also be described as exemplary in its scope, completeness and depth of explanation.

To sum up, the IPX amplifiers are genuine hightech installation devices of the upper performance class, which fully meet all requirements in terms of flexibility, stability and functional scope. //