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Test & Measurements
Extron XPA U 4004 FX

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Extron XPA U 4004 FX

With the XPA Ultra FX series, Extron has three new installation amplifiers in the mid-range power class that can deliver 200 W to 800 W per channel in Low-Z and 100V mode and are optimized for exceptionally high energy efficiency. ECO Standby technology switches the amplifier to standby mode after just a few seconds without signal, with a power consumption of less than 1W, and the InstaWake+ function returns the amplifier to full power within 5 ms.

Text, measurements and photos: Anselm Goertz

In the installation sector, with ever-increasing technical facilities for audio, video, and security technology, the energy consumption of these devices is becoming a critical issue. Most of these systems are operated 24/7, and even low power consumption significantly impacts costs over time. In addition, devices with low power dissipation and less heat generation have a longer service life and cause lower peripheral cooling costs.

The California-based manufacturer Extron has taken up this challenge and introduced three new amplifier models with four or eight channels, the Ultra FX series, specifically developed with energy efficiency and sustainability in mind. In this context, sustainability means not only consuming less energy but also designing devices so that they last a long time, for example, by placing temperature-critical components, such as capacitors, in cool zones within the enclosure. Let’s now take a closer look at the Ultra FX series.

Ultra FX amplifier series

Extron presents the new amplifiers with the slogan “Ultra Flexible, Ultra Cool, Ultra Efficient". What is behind this? The three models, 2008, 2004, and 4004, of which the XPA U 4004 FX was tested, already have the number of channels and their power in the product name. 4004 means four channels of 400 W each, or 2008, eight channels of 200 W each. All channels can be configured independently for Low-Z operation at 4 Ω or 8 Ω or for 70 V or 100 V systems, optionally with or without a high-pass filter in the signal path. In addition, two adjacent

channels share their power output with power sharing so you have either 2 × 400 W or 1 × 800 W and all intermediate values available.

The internal structure is, as usual, clear and tidy without interconnection cables, apart from the connection cables for the two fans and the connection from the power socket to the power supply board. The fact that the power amplifiers are Class D types hardly needs to be mentioned these days, especially when the focus is on energy efficiency.

In contrast to other amplifier models, the supply voltage of the individual channels in the Ultra FX models is not adjusted for the different operating modes (Low-Z, 100 V). As the measurements show, the full voltage range of ±155 V is available for short pulses in the Low-Z mode. The limitation is then achieved through a current limiter. The power supplies for the Ultra FX models, as with most other devices and external power supplies from Extron, use proprietary developments called "Everlast". The name "Everlast" is a reference to reliability and durability. Since power supplies play a central role in all electronic devices, a failure usually does not remain without serious consequences. For rugged 24/7 use, Extron did not want to rely on widely used standard power supplies and, as a result, developed their own Everlast power supplies.

If you look at the inside of the XPA U 4004 FX (photo 2), you can see the structure already mentioned, in which temperature-critical components are located in cool zones. Electrolytic capacitors are particularly at risk, as they are one of the leading causes of failures in devices that are in operation 24/7. Electrolytic capacitors dry out internally due to high temperatures, lose capacity and can ultimately also cause short circuits. Consequently, in the XPA U 4004 FX they are placed on the main board away from the heat sinks and close to the air inlets..

Energy efficiency

Nowadays, the topic of energy efficiency is omnipresent, and for good reason. The constantly growing media technology also needs to be reviewed in this context. If you look at amplifier technology from this perspective, there has undoubtedly been huge progress in the last few decades. Twenty years ago, voice reinforcement systems in large buildings, with significant power loss measured in kilowatts, could generate enough heat to make air conditioning necessary for continued operation. With the introduction of switching power supplies and Class D circuits, power amplifiers became significantly lighter and much more efficient. Class D power amplifiers have the advantage of being significantly more efficient than the previously common Class AB and Class H, since the power amplifier transistors only work in a high frequency switching function, where the power loss in the transistor is minimal. Small Class D power amplifiers, therefore, require almost no cooling. Where huge heat sinks were previously required, today, as in the Ultra FX models, a small internal cooling profile with some ventilation is sufficient.

Nevertheless, there is still room for improvement here, especially when it comes to power amplifiers in building technology that must run 24/7. Just 20 W of idle power consumption for a power amplifier adds up to 175 kWh over the course of a year. Standby functions can help with this, but they have one challenge:

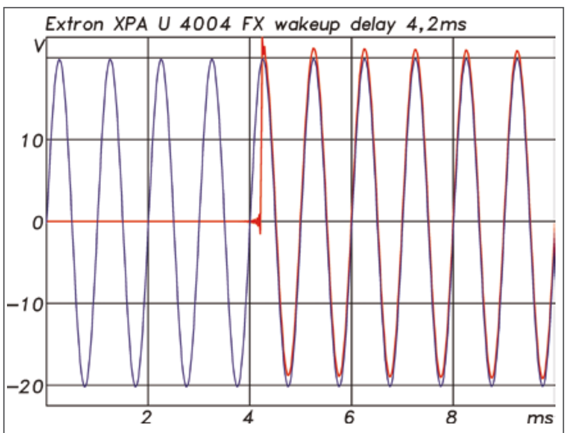
How long does it take for the power amplifier to be fully operational when needed? In a small diagram on the Ultra FX series homepage, Extron shows some of the ➔

Looking under the hood of the XPA.

Photo 1: Interior view of the XPA U 4004 FX. The 19" 1U housing is fully utilized for the four power amplifier channels plus power supply and peripherals.

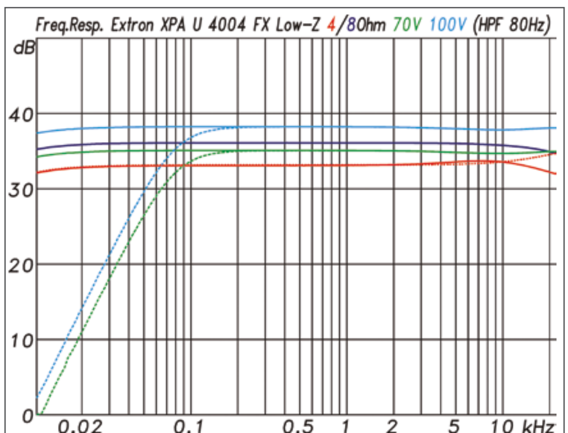
times, ranging from the XPA series with around 500 ms to the XPA Ultra with 100 ms to the XPA Ultra FX presented here with less than 5 ms.

InstaWake+ is the name given to the technology used to quickly start the power amplifiers from standby mode. A quick measurement (Fig. 1) shows that the XPA U 4004 FX delivers the full output level after just 4.2 ms so even with critical announcements, you don't have to be worried that they might become incomprehensible due to the lack of the first syllables. In addition, the Ultra FX amplifi-



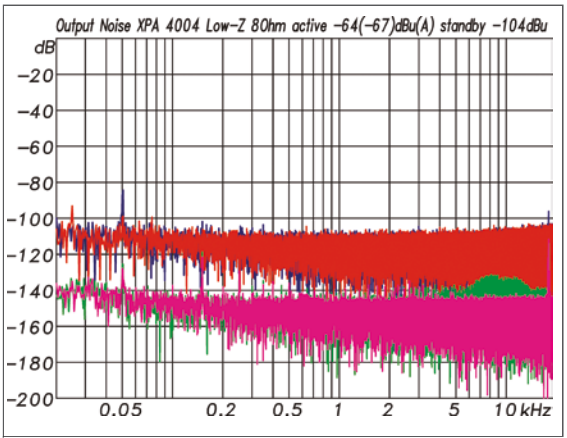
Wake-up time

Fig. 1: Thanks to the InstaWake+ function, the power amplifier returns back from standby into normal operation within a period of less than 5 ms as soon as a signal is present



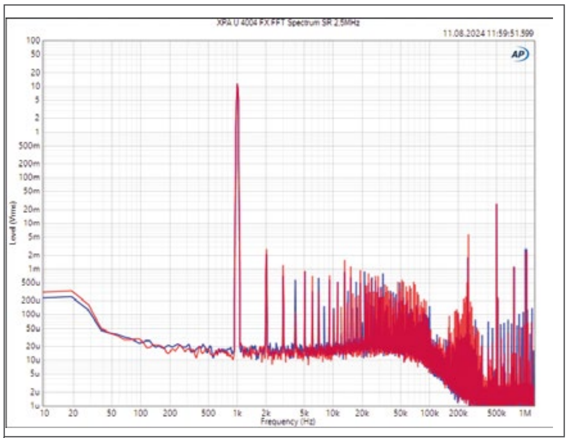
Gain values

Fig. 2: Depending on the mode set Low-Z, 4 Ω or 8 Ω, and 70 V or 100 V, the gain of the power amplifier is adjusted so that full output is achieved at +4 dBu at the input. The optional 2nd order high-pass filter has a cut-off frequency of 80 Hz.



Noise FFT spectra

Fig. 3: Noise level at the output in standby mode (gr,rs) with -105 dBu(A) and in active mode (rt,bl) with -69 dBu(A). In contrast, in Low-Z 8 Ω mode, there is a maximum output level of approx. +40 dBu.



2.5 MHz FFT spectrum

Fig. 4: FFT spectrum of the output signal measured with a 2.5 MHz sample rate. The useful signal can be seen at 1 kHz with a voltage of 10 Vrms. Remnants of the PWM switching frequency can be found at around 250 kHz and the integer multiples..

ers also support the classic standby function, which switches the amplifier to standby mode either after around 20 minutes without a signal or via an external contact. In this context, the power consumption in standby mode, which is less than 1 watt, should not go unmentioned.

Low-Z, 70V and 100V

Permanently installed sound systems in public buildings, exhibition centers, hotels, etc. usually require many amplifier channels with low and medium power. High-performance power amplifiers, such as those used in stage technology, are rare here. In addition, depending on the type of loudspeaker and cable length, low-impedance (Low-Z) types or 100 V or 70 V lines may need to be supplied. In the past, the latter was mostly used with the help of transformers at the output of the power amplifiers, which adapted the output of the power amplifier to the 100 V system. However, transformers are heavy, expensive and lossy. Modern Class D power amplifiers, therefore work with direct drive, which means that the power amplifier can supply the output voltage of ±150 V required for 100 V systems on its own. In the Ultra FX series, each channel can be individually set for Low-Z with 4 Ω or 8 Ω or for 70 V or 100 V systems. Using a recessed rotary switch (photo 4) on the rear panel, the setting is very simple. The available number of channels remains unchanged. Bridge circuits are not required.

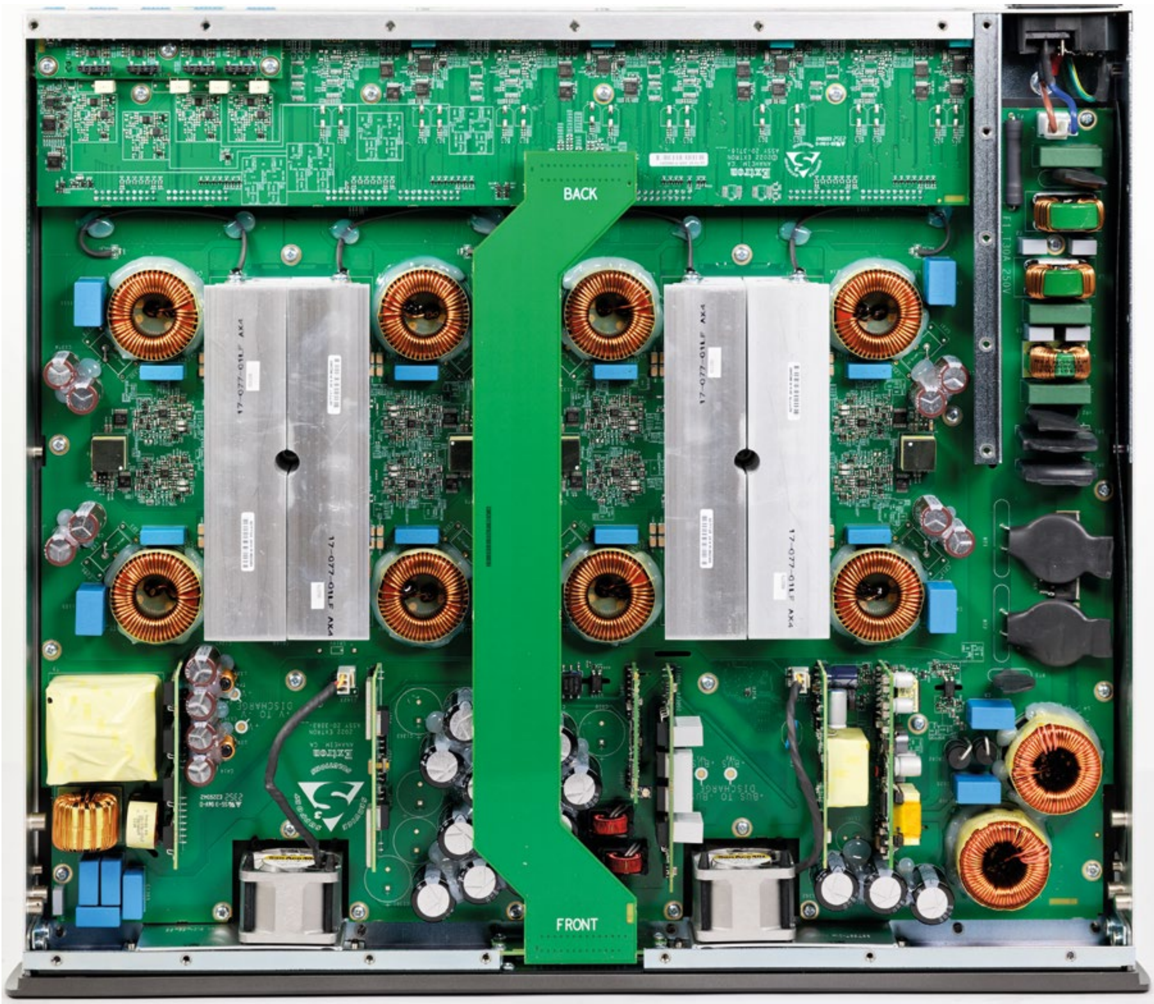
The Ultra-FX amplifiers can therefore, also be used in systems with mixed Low-Z and 70 V/100 V loudspeakers without any problems. Depending on the mode set, the channels adjust their internal gain so that the full output power is always achieved at around +4 dBu. For the 70 V and 100 V modes, there is also the option of a 2nd order High-pass filter at 80 Hz. For speakers with transformers, the high-pass filter should always be used, as the impedance of the transformer usually drops significantly at low frequencies (<100 Hz) and can thus overload the power amplifier. In addition, transformers quickly saturate low-frequency signal components which leads to distortion in the signal. Typical 100 V speakers are usually not designed for bass reproduction anyway, the high-pass filter in the signal path can and should always be activated.

Another plus point in terms of flexibility in the UltraFX series is power sharing. Two adjacent channels share a power pool of the power supply. If only a small amount of power is required from one channel, then more is available to the other.

Measured values

The first measurement is, as always, the frequency response measurement. In Fig. 2 for various operating modes, you can see very straight curves in addition to the adjusted gain values, which only show slight fluctuations even at high frequencies. Presumably, a correction will be made here depending on the set load.

The noise level measured at the outputs of the XPA U 4004 FX in active mode is -64 dBu unweighted and -67 dBu with A-weighting. The FFT spectrum of the noise signal in Fig. 3 shows evenly distributed noise without single-frequency components. If you set the maximum output voltage of approx. 150 V peak in relation, ➔



Internal Structure

Photo 2: The four power amplifier channels arranged around the cooling profiles are clearly visible. The mains filter is at the back right, and the power supply is at the front. Two small fans ensure that the waste heat is dissipated. Cold air is sucked in through a dust filter at the front and then exits through the holes on the back.

this results in a S/N (signal-to-noise ratio) of a good 107 dB with A-weighting. Calculating slightly differently with the output voltage available at 8 Ω for a sine signal of 67 Vrms and -64 dBu linearly weighted noise level, you get a S/N of 103 dB. The data sheet states 100 dB.

Another quick measurement for Class D amplifiers is the FFT analysis of the output signal with a very high sampling rate. Fig. 4 shows this measurement with a sampling rate of 2.5 MHz, the highest value possible with an APx555. This type of measurement shows both the Class D switching frequency and possible interference within and outside the audio frequency range. For the measurement in Fig. 4, a 1 kHz signal was used. The amplitude of the useful signal at the output was 10 V in this measurement. The PWM switching frequency is around 250 kHz, and its integer multiples are clearly visible. The voltage values of the high frequencies are 30 mV and less and are, therefore unproblematic.

Two further measurements show the values for the crosstalk attenuation and the damping factor. The crosstalk attenuation (Fig. 5) indicates the value in which a signal from one channel crosses over to an adjacent channel. A high level of crosstalk attenuation is primarily evidence of a good circuit concept and board layout and can therefore also be considered as a general quality criterion for an amplifier. For the XPA U 4004 FX, the values are around -80 dB and then increase at higher frequencies by around 6 dB/oct. Values in this order of magnitude are practical and typical.

Formally, the damping factor of an output stage is the ratio of a connected load impedance to the internal resistance of the source. If, for example, the load impedance is 8 Ω and the source's internal resistance, in this case the power amplifier, is 100 mΩ, then the damping factor is 80. A low internal resistance of the source, ideally 0 Ω, is important for loudspeakers because it slows down the resonance of the membranes and, if the loudspeaker has a passive crossover, it prevents crosstalk between the branches. Like so many things in audio tech-

Rear Panel

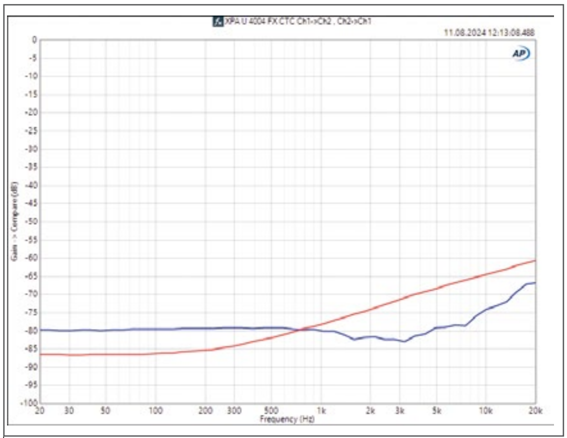
Photo 3: On the back of the 1U housing are the inputs and outputs with two- and three-pin Phoenix connectors as well as the selector switches for the operating mode and the gain controls for the four channels.

nology, the damping factor is a frequency-dependent value. The measurement is carried out by taking the amplifier's two separate frequency response measurements, once with and once without a load. The internal resistance can then be calculated based on the level loss of the measurement with load in relation to the measurement without load. Fig. 6 shows the values for the level ratio in dB for an 8 Ω load. Over a wide frequency range, the value is -0.035 dB, which results in a damping factor of 250. Above 1 kHz, however, the curve reaches a value greater than 0 dB, which means that the output voltage increases slightly when a load is connected, which is not actually possible. The reason for this lies in the amplifier circuit, which is slightly overcompensated at higher frequencies, so that purely mathematically, they appear as a negative internal resistance of the amplifier, which compensates a little for the influence of the low-pass filter at the output. The damping factor, therefore, increases, purely mathematically, to values approaching infinity.

Distortion measurements

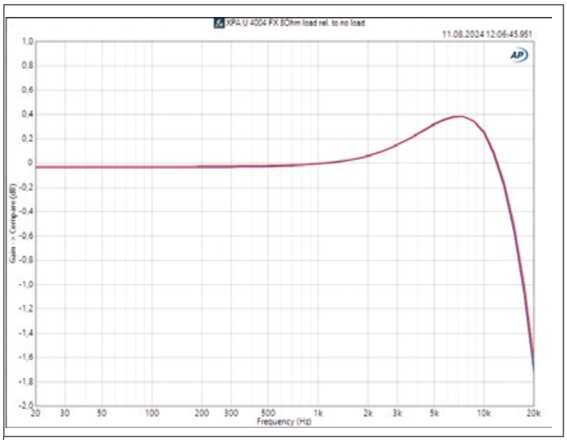
Four further measurements deal with the distortion behavior of the amplifier. Fig. 7 shows the THD values as a function of the output power, measured at frequencies of 100 Hz, 1 kHz and 6.3 kHz for a load of 4 × 8 Ω with all four channels operating simultaneously. At 100 Hz and 1 kHz the curves are in the order of magnitude of -70 dB (=0.03%) and only increase at the clip limit. At 6.3 kHz the THD values are somewhat higher at around -60 dB and the increase before the clip limit also begins much earlier. Values of this magnitude would not generate enthusiasm with high-end audiophiles but are completely sufficient for typical applications. The distortion value specified in the data sheet of 0.1% (-60 dB) at 1 kHz 3 dB below the clip limit is safely met at -67 dB.

How the distortion values behave over the frequency measured at a constant level can be found in Fig. 8. The measurements were made from 20 Hz to 6.3 kHz at ➔



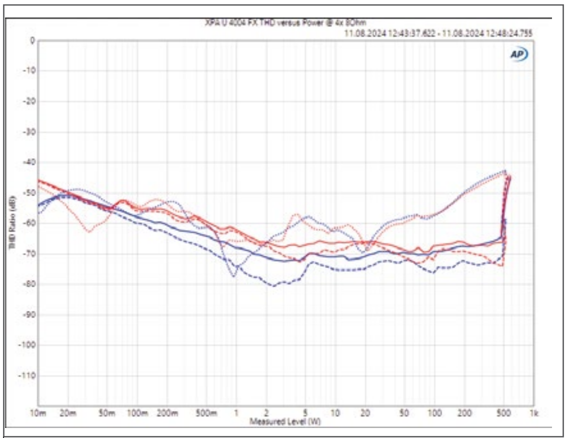
Crosstalk attenuation

Fig. 5: Crosstalk measured as an example from Ch1 to Ch2 (blue) and vice versa from Ch2 to Ch1 (red).



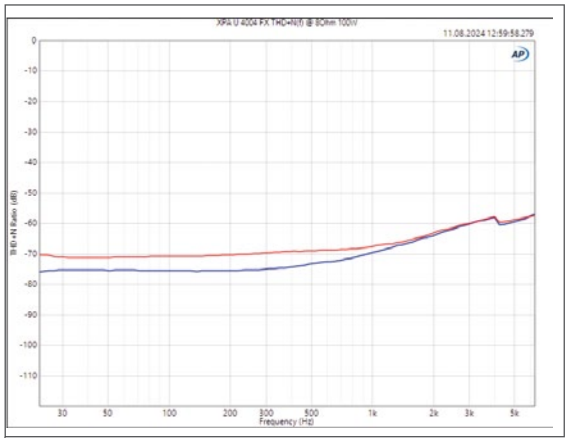
Internal resistance

Fig. 6: Quotient of a frequency response measurement with an 8 Ω load and without load. The damping factor is calculated from the level loss under load, which is about 250 based on 8 Ω below 500 Hz. Between 1 kHz and 12 kHz the level increases with the load, the power amplifier develops a kind of negative internal resistance. Such an effect can arise from overcompensation in the negative feedback.



THD over power

Fig. 7: Total harmonic distortion (THD) as a function of the output power (x-axis in W) at a 4×8 Ω load. Measurements at 100 Hz (– – –), 1 kHz (– – –) and 6.3 kHz (···).



THD over the frequency

Fig. 8: THD+N over frequency measured on an 8 Ω load at 28.3 Vrms output voltage corresponding to a power of 100 W.

an output voltage of 28.3 V on an 8 Ω load and thus at a power of 100 W. The already known values at 100 Hz, 1 kHz and 6.3 kHz from Fig. 7 are confirmed here. Overall, the curve is even and free of weak points.

The distortion spectrum from Fig. 9 was also measured at 100 W at 8 Ω. The harmonics are all 70 dB or more below the fundamental wave with a dominance of k3. Many higher order components are not so nice and you would expect to see a rapid drop to the higher orders. But here too, the values are completely sufficient for typical applications.

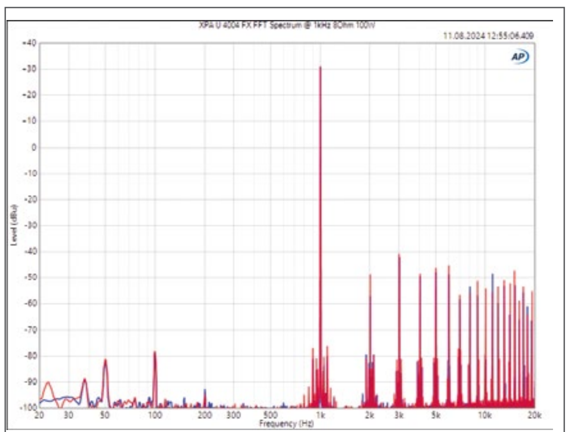
The transient intermodulation distortions in Fig. 10 were also measured for a load of 4 × 8 Ω. At higher levels, the DIM100 values are between -65 and -50 dB. The overall unstable curve is somewhat unusual..

Performance values

The power measurement for the XPA U 4004 FX was only carried out in Low-Z mode for a single and a four-channel load with 8 Ω load resistors. The following diagrams Fig. 11 and Fig. 12 show the power values measured in this way. To be comparable with the manufacturer's data, we carried out a series of different measurements according to different standards.

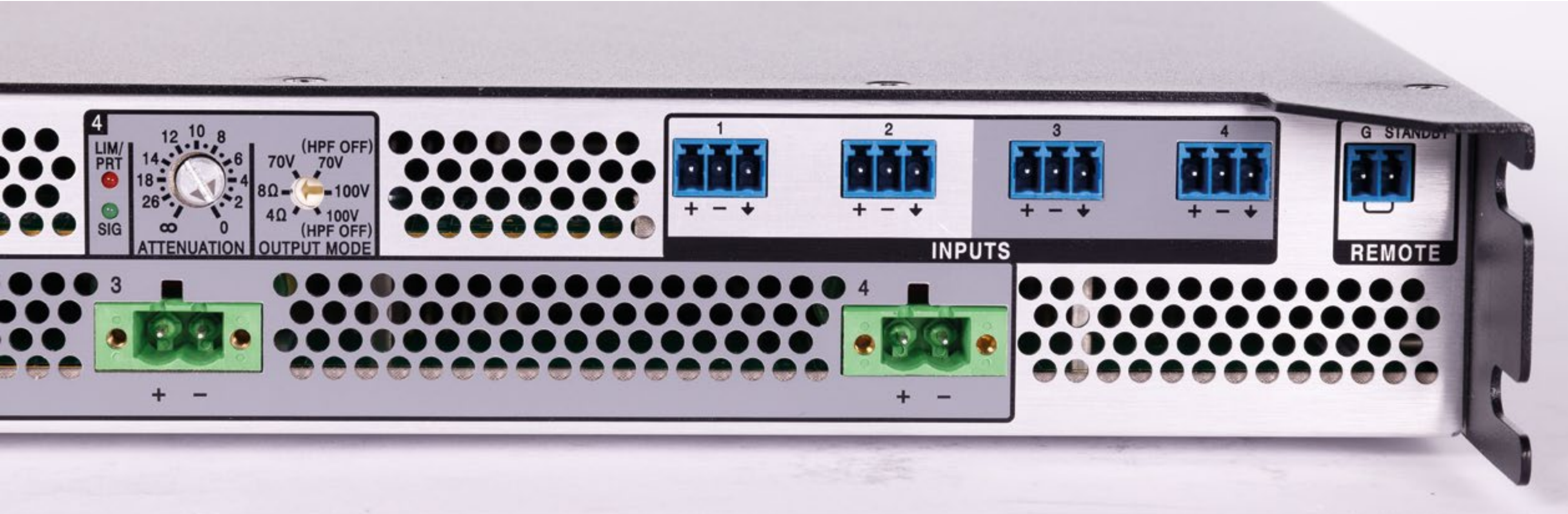
In detail, the following values are determined:

- the pulse power for a 1 ms single period of a 1 kHz sinusoidal signal
- the sinusoidal power of a constant 1 kHz sinus signal after one second, after ten seconds and after one minute
- the performance with a constant noise level of 12 dB crest factor after ten seconds, one minute and six minutes
- the performance with a constant noise level of 6 dB crest factor after ten seconds, one minute and six minutes
- the power according to EIAJ measured with a pulsed 1 kHz sine signal of 8 ms duration every 40 ms. The signal has a crest factor of 10 dB.
- the performance according to CEA 2006 with a 1 kHz sine signal whose level experiences a level jump of +20 dB for 20 ms every 500 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



FFT spectrum

Fig. 9: Distortion spectrum exemplary for Ch1 (blue) and Ch2 (red) at 4 × 100 W power into a 4 × 8 Ω load. All distortion components are 70 dB (0.033%) and more below the 1 kHz fundamental and are therefore not critical.



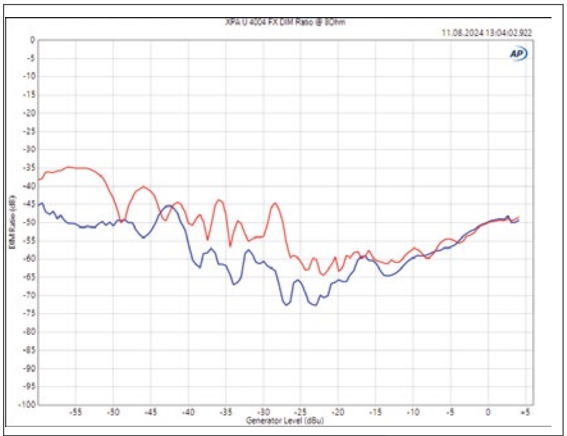
Output mode selector switch

Photo 4: For each of the four channels there is a mode switch for low-Z operation at 4 Ω or 8 Ω as well as for the 70V or 100V mode, both with and without high-pass filter.

crest factor of this signal is 7.8 dB.

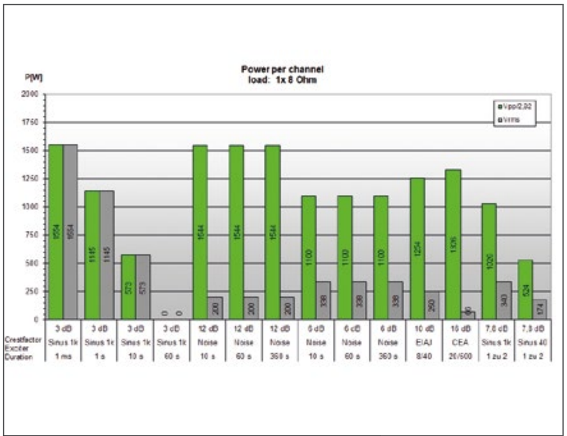
– the power for a periodically repeating 40 Hz burst of 825 ms followed by a 1,650 ms rest phase. The crest factor of this signal is also 7.8 dB.

The evaluation is easy for the sinusoidal measurement signals. You record the RMS value and calculate the power. The sine wave should not yet be visibly distorted. Two values can be determined for the sinusoidal burst signals according to EIAJ or CEA. Firstly, the short-term RMS value during the duration of the burst and the overall RMS value, including 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, which describes the ratio of the peak value in the burst to the overall RMS value, is 3 dB higher in each case and is, therefore, 10 dB or 16 dB. For the burst measurement methods, the overview shows the power values calculated from the short-term RMS value of the burst and the overall RMS value. Another burst measurement method works with 33 ms long 1 kHz



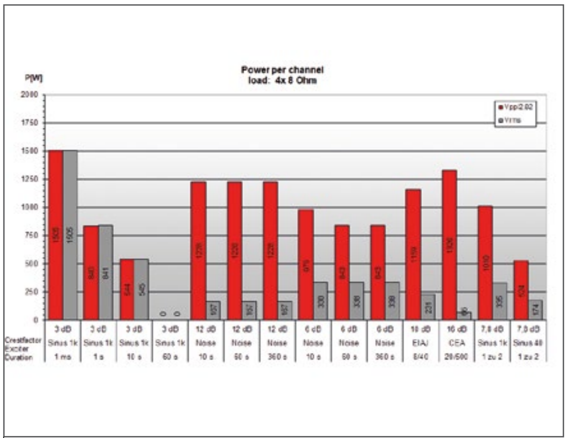
Transient intermodulation distortion

Fig. 10: Transient intermodulation distortion (DIM100) for Ch1 (blue) and Ch2 (red) as an example depending on the input level measured at a 4×8-Ω load. The curve is unusually unstable.



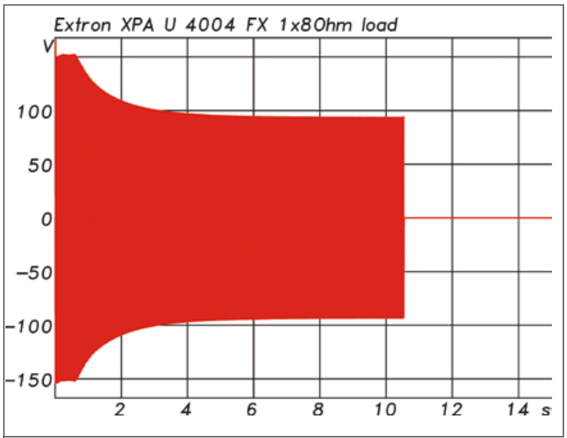
Performance values single channel

Fig. 11: Performance values of the XPA U 4004 FX an 8 Ω with single channel loading with different signal types. See text for details.



Performance values four-channel

Fig. 12: Performance values of the XPA U 4004 FX an 8 Ω with four-channel load and different signal types. See text for details



Constant 1kHz sine signal

Fig. 13: Behavior of the XPA U 4004 FX with a constant sinusoidal signal for maximum output power at an 8 Ω load. First a limiter kicks in and after just over 10 s the device switches off due to overload..

bursts, followed by 66 ms long rest phases. 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 spans were extended by a factor of 25, especially with regard to the capabilities of an amplifier for bass reproduction, were tones often last longer.

It is not possible to say in general 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 12 or 6 dB crest factor is somewhat different. The amplifier is driven with these signals up to its clip limit and then permanently loaded. The peak-to-peak value (Vpp) and the effective value (Vrms) of the signal are measured after ten seconds, one minute and six minutes. From this, a power value is calculated from the effective value of the voltage and one is calculated from the peak-to-peak value divided by 2.82.

The values are therefore, comparable with the values of the burst measurements. The measured values show very high peak power and stable behavior even over longer periods of time. The noise signal with a crest factor of just 6 dB runs stable over the entire test duration of six minutes with an average power of 338 W per channel. The same goes for the noise with a crest factor of 12 dB, where the average power is then 167 W. With a constant sinusoidal signal, a full ±155V can be measured undistorted for approx. 700 ms on an 8 Ω load at the beginning. A limiter then intervenes and reduces the output voltage to ±93 V, which still corresponds to an output of just under 550 W. After just over 10 s, the device is switched off due to overload. At this point, the question arises of whether it would be better to configure the limiter in such a way that an overload condition does not occur in the first place. On the other hand, a constant sinusoidal signal is not a practical case but rather a typical laboratory measurement.

Network load

The load on the power supply is an important issue for high-performance power amplifiers and/or long operating times. Installation costs, operating costs, and, ultimately, operational reliability are directly or indirectly related to this. If the power amplifiers are in continuous operation, the power consumption in idle mode without a signal is an important value. For the XPA U 4004 FX, the power consumption in idle mode is less than 1 W. The decisive factor here is that, thanks to the technology that switches the power amplifier to idle mode just a few seconds after the signal is no longer present, there are almost no times when the power amplifier is idle, fully active, but without a signal.

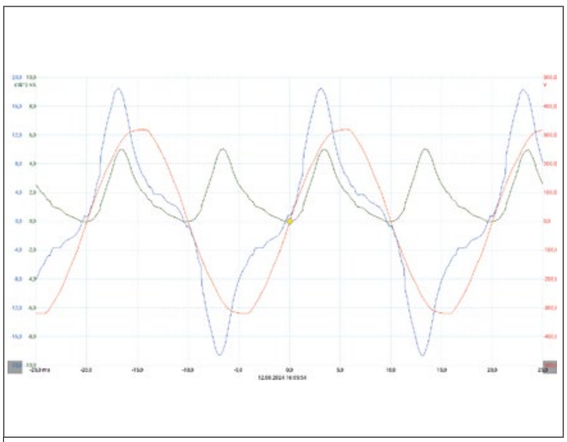
When idle, the power consumption of the XPB U 4004 FX is approx. 18 watts. For the extreme case of full control with a sine wave of 4 × 400 W, which probably rarely occurs in practice, the mains load is a maximum of 1,750 W. If all four channels are connected to a 12 dB crest factor signal is fully controlled, then the mains load is 720 W, which corresponds to an output power of 650 W.

In addition to the absolute values and the power from the mains, the current consumed should follow the voltage as closely as possible and the output stage should thus behave like a real resistor as a load for the power grid. Deviations arise from displacement reactive currents (capacitive or inductive) and from distortion reactive currents (harmonic component). How well the current curve approximates the voltage curve is expressed in terms of measurement by the power factor (PF). Fig. 14 shows the measurement of the XPA U 4004 FX at full load with 4 × 400 W. The power factor is 0.85 and the cos-φ-value for describing the phase position of voltage and current to each other is 0.94. Both values show an effective network utilization without large reactive currents or harmonic components. There are no high-frequency interference components. Fig. 15 shows the efficiency of the power amplifier in more detail with two curves. The blue curve shows the output power in relation to the total output power of the active power that is drawn from the power grid. Together with the base load, this results in rather low values for the efficiency at low output powers. For the red curve, the output power is only related to the power drawn in addition to the base load. The power amplifier itself thus achieves a consistent efficiency of 80% to 95% without a base load.

Conclusion

With the Ultra FX series, Extron has launched three new amplifier models that cover a very wide range of applications in AV technology with outputs of 4 × 200 W, 8 × 200 W and 4 × 400 W for low impedance loads and for 70/100 V systems. The XPA U 4004 FX presented here can easily drive even larger PA speakers with its performance values or feed extended 100 V lines. The workmanship is perfect, as is the internal structure as well as all connection options and controls. The values from the data sheet are all met or exceeded. Nothing unusual so far. With InstaWake+ technology, the power amplifier has another inconspicuous but even more important feature to offer. ECO Standby ensures that the power amplifier no longer has an idle state, but only switches between operation with signal or standby with less than 1 W power consumption. With a wake-up time of less than 5 ms, the InstaWake+ function can be used anywhere without any problems.

If we go back to the beginning of the article, you only can fully agree with the slogan "Ultra Flexible, Ultra Cool, Ultra Efficient". •



Mains voltage, current and power

Fig. 14: Line voltage (red), line current (blue) and the resulting calculated power consumption (green). The power factor is 0.86 and the cos- φ value is 0.94. The distortion component of the current with an effective value of 9 A is approximately 38%.

Efficiency

Fig. 15: Efficiency of the XPA U 4004 FX power amplifier in % depending on the output power (x-axis). In red the curve without base load, which shows a very good efficiency of the power amplifier. For very low power (<10 W) the measured values are subject to a certain inaccuracy.

XPA ULTRA FX
POWER AMPLIFIERS

Ultra Flexible • Ultra Cool • Ultra Efficient
High Power, Energy Saving 400 Watt Amplifier

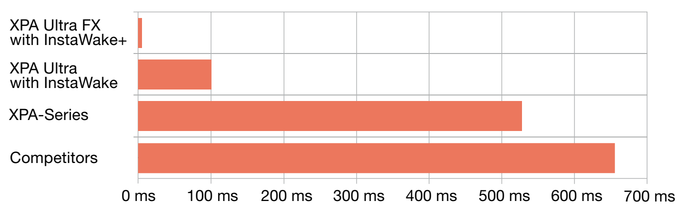
The **XPA U 4004 FX** four channel multi-zone audio power amplifier features ECO Standby with InstaWake+™ technology to maximize energy savings by delivering power only when it is needed. The amplifier is easily configurable per channel to support large systems of multiple speaker types with dynamic power allocation up to 800 watts per channel at half the channel count. Exceptional flexibility and power density in one rack space establishes the XPA Ultra FX Series as the new go-to, high power amplifier solution for your next installation.

Features

- Four 400 watt channels
- Configurable output modes per channel
- Each pair of channels dynamically shares 800 watts of total power
- ECO Standby delivers power only when needed, maximizing energy savings
- InstaWake+ returns to full power from standby in under 5 milliseconds
- ENERGY STAR qualified amplifier

InstaWake+

With industry-leading InstaWake+ technology, XPA Ultra FX goes from standby to full power in less than 5 milliseconds. For demanding applications where every millisecond counts, InstaWake+ ensures that critical audio content is never lost.



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