

PPP Quietening the Mains?

MARTIN COLLOMS ANALYSES PS AUDIO'S UPMARKET POWER PLANT PREMIER MAINS CONDITIONER

MARTIN COLLOMS

Much has been said about the declining purity of our mains supply and the effect this has on the more subtle aspects of sound quality: inner rhythms, micro dynamics, low level detail, treble purity, and the proper recovery of reverberant sound field information.

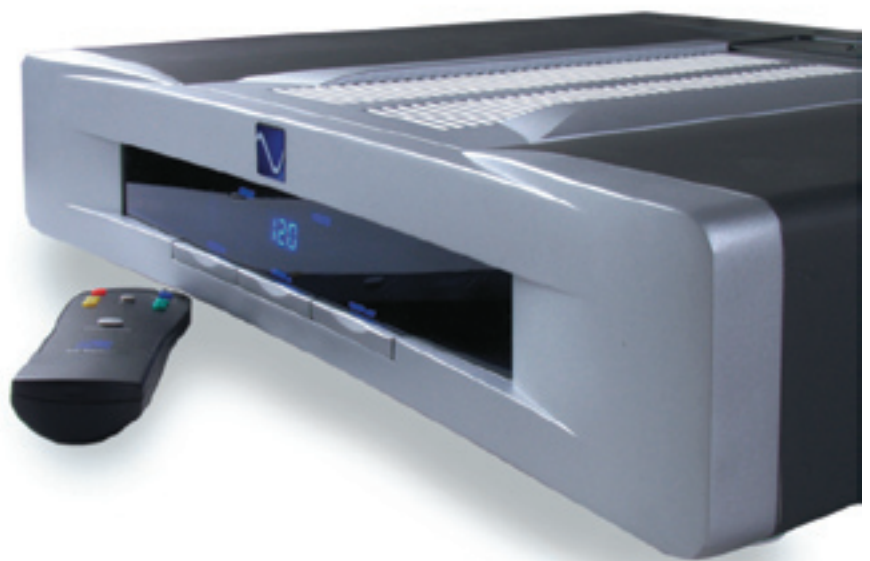
Various methods of variable success have been proposed to deal with mains pollution, and the problem is complicated by the two dependant effects: first the fundamental noise and impedance characteristic of the mains in the particular locality; secondly the further contributions made by the powered components of your system, as well as all the other stuff in the building. The latter runs the gamut from domestic appliances to TV, via the legion of noisy switch mode (SM) supplies feeding low voltage lighting, laptops and other peripherals, including display screens of various types, not forgetting fluorescent lighting and/or dimmers.

Significant waveform distortion is present, some due to the huge countrywide installed base of low grade iron-cored transformers used for low voltage lighting which suffer from core saturation (see Ben Duncan, *HIFICRITIC VOL 1 NO 6 'The Trouble With The Mains'*). These add third harmonic distortion at 150Hz to the supply, which may be rendered audible by protesting power supplies in your audio equipment as a characteristic mechanical hum. It may also impair their sound quality

When the listening environment suffers from audible extraneous noise – hisses and whistles, from traffic noise, air conditioning fans, mechanical and electrical hum etc – one will not hear as much as one could or should, as a 'noise floor' can mask lower level sounds. The effect of electrical noise on the mains is subtle. It is usually easier to hear when it has been removed. Then reinstating the previous polluted status quo better informs how much sound quality is being lost.

Mains quality fixes vary hugely in price, complexity and efficacy. Many are mere palliatives, where an effective solution is only possible at great expense. When I have tried the simpler fixes – filters, mains shunt capacitors in plug tops and suchlike – these have often made the sound available via my good quality separate spur supply worse. However, I accept that some of these may patch up poor quality mains.

With no expense spared and where a direct spur supply is simply not possible, an isolating balanced output transformer is effective if massive and generally



noisy (mechanical hum). Because of the hum problem, these devices should ideally be located remotely, say in an adjacent room. They are particularly good in removing the often dominant DC component (the second harmonic) of mains distortion, a harmonic which also upsets the power supplies in audio components and causes further mechanical hum.

PS Audio's PPP

Signature Audio Systems, PS Audio's UK agents, responded to my request and brought the £1800 *Premier Power Plant (PPP)*, with a useful personal briefing on how not to misuse it on first installation – a particular issue with 'active' electronics operating on 240V mains power. It was brave of Signature to bring it over, as my track record on mains 'improvers' and 'filters' have been generally negative in the past, as they have tended to degrade my system. It seems that I have quite good quality mains, with decent voltage (typically 243V) and moderate distortion (typically 3-4%), and my system is supplied by two dedicated spurs wired with 60A wideband cable. Put anything in a spur's way and it usually results in a mild but significant loss of timing precision, less clarity, diluted dynamic interest and excitement, albeit perhaps with occasional small improvements in treble sweetness and stereo image precision. Some filters and suppressors can take the system quality down by as much as 15%.

These particular mains quality improvers have been

around for while and show no signs of going away. Reputable exhibitors have been using them at hotel audio shows to recover some sound quality from the highly polluted available electrical power, not least from all the other exhibitor's equipment on line.

When I reviewed the £1,700 Isotek *Titan*, a passive mains filter (*HIFICRITIC Vol 1 No 4*), and initially determined that it provided little loss but no benefit, I put aside my power spurs and fed the audio system from the alternative regular ring main using a socket strip. On a simple A/B basis the loss when moving from the dedicated spurs can be striking and shocking. The procedure in part simulates poorer mains, a higher source resistance and increased noise from the other devices, electronic lamps, computers, power supplies for phones etc, which are also present on the ring.

The results using the house ring are generally unacceptable and disappointing for me, at 65-70% of the optimum. Under these degraded conditions the insertion of the *Titan* did now show a worthwhile benefit, managing to bring the system sound to a more than satisfactory 75-80%. The Ben Duncan designed balanced mains transformer (*HIFICRITIC Vol 1 No 5*) was even better at about 85%.

To analyse the PS Audio *PPP* I explored just how best to use it: whether to put the whole system on it, as if it was a socket extender; or be selective and try different component combinations. It has some subtle control features, and this also required further analysis, alone and in different combinations of my audio system components. All in all there was quite a lot to do. Signature also supplied a hawser-like PS Audio mains cable, which we later discovered was an audio component in its own right, and also *Duet* and *Quintet* passive filter power bars.



Features and Operation

In contrast to many mains improvers, whose fancy casework often conceals not a lot (essentially a means to wire up the internal connections with a few bits, filters etc), the PS Audio *PPP* is positively crammed with electronics. Its many operational features are also conveniently accessed *via* remote control, signified by an electronic display which may be dimmed or muted. This provides information about the operating state, for example indicating master power on, input voltage and distortion, output voltage and distortion, and other enhanced modes such as 'CleanWave' and 'MultiWave'. A set screw on the underside allows some user variation of output voltage relative to the input tracking, for example to optimise the operating level for more critical devices. Depending on the time of day, I found 3-6% distortion indicated on my incoming mains, which when regenerated was almost invariably at the threshold reading of 0.3% (except when my 400W/ch power amp was driven really hard, when it flickered up to 0.4%).

In brief the *PPP* is a mains improver, which also scales the input voltage down by a small amount (about 5%) and which incidentally avoids the effects of over-voltage on more sensitive equipment (often US electronics with 230V nominal input ratings). It also claims to reduce harmonic distortion on the power line typically by a factor of 10, and provides a low noise, very low mains source impedance (just 15 thousandths of an ohm for powerful amplifiers), together with additional high frequency filtering. Output is at local frequency (eg UK 50Hz) *via* five high quality output sockets, filtered in zones for further isolation between connected electronics. Overload and lighting strike circuit breakers are fitted, and outlets are under selected control for delay and 12V trigger power-up as required (a boon for complex multi channel installations).

The current *PPP* replaces a line of differently sized conditioners, which were essentially high quality power amplifiers, supplying synthesised mains level power, similarly priced and as big as any dreadnaught solid state power amp. The *PPP* uses a new approach where the incoming mains is filtered, and then powerfully conditioned by supplementary electronics to 'regenerate' it. The result is a stable, low impedance, low noise output voltage with generous 20A peak current; power rating is 5kW short term and 1.5kW continuous.

The new design provides high power at more moderate size and cost, as the previous full power regenerator amplifiers have been supplanted by a small efficient amplifier operating in Class 'G', which

tracks the incoming waveform like a bronco rider, instantaneously 'cleaning' the power.

A patent has been filed for the inventive component of this technology, in which a small high current and responsive amplifier, provided with its own isolated supply and control, rides the crest of the incoming mains, electrically floating on it, and provides the inverse of the waveform errors present, allowing the errors to sum to zero.

Strictly, Class G amplification employs a main circuit of conventional design, supplemented by secondary higher voltage rails for additional transistors which efficiently operate only on the waveform peaks.

Unaltered in frequency, the output 'mains' is reduced by a few volts (the operating headroom for the correcting amplifier). Since the incoming noise and distortion represents only a few percent of the voltage and power, only a few watts is required to address them, hence the small size and efficiency (only 16W idling) of the Class G correction amplifier.

PS Audio begins with its high current, high saturation micro crystal cored inductor/capacitor filters, using components selected for sound quality as well as RF filtering performance. Five independently filtered supplies help system components from interfering with each other.

Listening Tests

We actually carried out some 38 listening tests in all, which is too many to describe in detail, so a summary will suffice.

Preliminary experiments found that the *PPP* consumed just a few watts of power itself. Plugging it into my spur and connecting my entire system to it (including the 400W/channel Conrad Johnson *Premiere 350SA*) gave some improvements in clarity and sweetness, but also a small loss in dynamics, rhythm and excitement. However, when compared with the best quality available from my system, the *PPP* exhibited the smallest quality loss from any conditioner tested so far, recovering a large measure of the original spur sound quality.

We tried out the available settings and found that MultiWave, which 'tunes' a synthesised harmonic power series to try and improve the charge current of the connected equipment and hence increase power transfer, did in fact slightly degrade the system sound, and also added subtle colorations.

Conversely the CleanWave function, which is an on-the-fly supply degausser (about which I had been highly sceptical) proved surprisingly effective. A touch on the remote button supplies a 5 second 'demag' before a track starts, and adds several percent to the clarity, especially



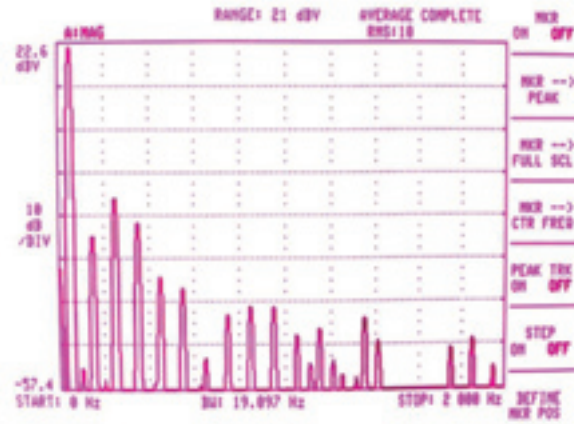
of the power amp. After first switch on, check the sound once the power amp has settled and then do a 60 second demag; the sound quality improvement is unmistakable.

It is suggested that the powerful switch-on transient (necessarily of undefined polarity) and inrush current 'sets' the transformer core. The demagnetization signal, comprising the usual slowly decaying sine wave at a low-mid frequency, and almost undetectable from the loudspeakers, 'relaxes' the polarised core magnetization to a largely unpolarised state. Subjectively it sounds as though the power amp has been returned from a much needed power supply overhaul.

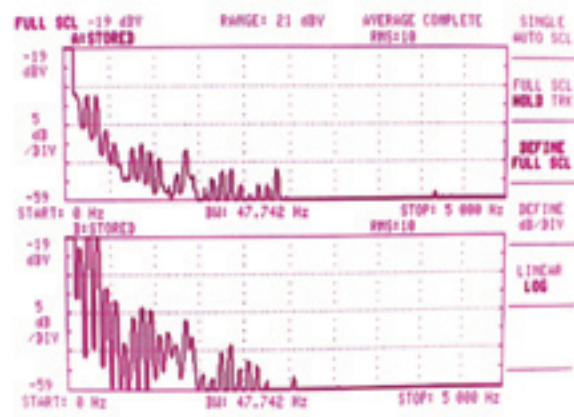
While the *PPP* is certainly the best mains conditioner we have yet tried, it was still not entirely better than the raw spur. There were some undoubted improvements, with a richer deeper soundstage, cleaner high frequencies, and deeper silences. But it also felt very slightly 'slower' and more deliberate, less dynamically involving and emotional, more cerebral and intellectual. For reference purposes we therefore benchmarked the raw spur at a system sound quality of 100%, and in comparison gave the *PPP* 95%, perhaps not good enough for unqualified approval at this stage.

However, we next re-connected the reference system directly to the spur and gave the *PPP* exclusive duty with the Conrad Johnson power amplifier. Now we had a result! The *SA350* noticeably improved in quality (we think partly due to better reverse isolation, *ie* less of the *SA350* power supply noise was now affecting the preamp and sources). Whatever, the system was now rated at 110, with no significant quality losses and the

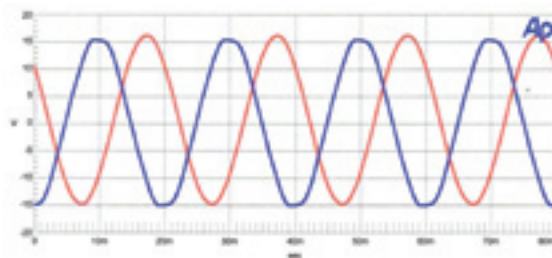
Fig 1: Noise and distortion on the mains, approx 4%



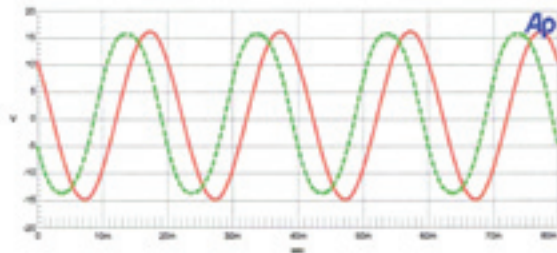
PS PPP: after and before regeneration, distortion now reduced to 0.4%



Power Plant Regenerator: Output (red) Mains Direct (blue)



Power Plant Regenerator: Output (red) Multiwave (green)



stereo and depth gains held up. With a 1960s Mozart violin concerto LP on Argo, Alan Loveday's playing was defiantly and unquestionably more natural with a richer 'singing' delivery. The note decays into silence were almost magical. Now we were getting somewhere.

We then repeated the 'simulated normal poor mains' connection using the regular house ring main, where the usually excellent system sound is crushed to around 65%. It took tens of minutes of listening to try to adjust to this loss, and in context I felt that this could not sensibly be done, in the short term at least. I experienced softer bass and with a subjective loss of low frequency extension, accompanied by muddy mids, grainy treble, less focus and clarity, and a loss in dynamics and timing. It was still pretty good – I had spent enough on the system in any case – but it was clearly compromised.

Now the *PPP* was used on the ring main, feeding the system via its sub zone isolated outlets. After a quick CleanWave degauss, and a few minutes more to let the (preheated but freshly powered up) units settle, we played music. The transformation was simply stunning. A high percentage of the loss noted above was amazingly restored. Clearly you can't make a very good power line better, but with this surprising regenerator you can bring a poor one back from the dead.

Our estimate was that some 91% of the original pure spur performance was recovered, and we could not hear any significant colorations or other artifacts. The system remained neutral and balanced with fine bass and no apparent restriction on maximum power. Those not particularly critical of rhythmic accuracy might consider it a 96% recovery, especially after using the degaussing button. Remember this result has been achieved with a rather pricey £60,000 system, and I can imagine many more difficult mains power situations where this economical and compact device will be an absolute lifesaver.

Lab Report

Using a wideband low voltage isolating transformer I connected the *PPP* output to my Agilent analyser and Audio Precision test set to explore mains noise and distortion on and off load.

Incoming mains distortion varied up to 6%, our first graph (Fig 1) showing the distorted, flat top waveform compared with the pure sine wave output from the *PPP*. The latter's distortion was typically 0.3 to 0.4%, agreeing with the *PPP* front panel display readings. I simulated a load comprising a 400W per channel amplifier at full power on a speech and music

duty cycle, delivering about 100W continuous into a test load. The effect on the *PPP* was not significant, barely altering the readings, and there was no trace of the 485Hz high power amplifier fundamental in the output. This also shows how the *PPP* output rail helps isolate the unwanted contributions of mains connected equipment from each other.

I checked the MultiWave option by choosing a poor, core-saturated test mains transformer with really flat waveform tops on its output, and found that it did restore the output shape. Conversely for a good transformer it increased waveform distortion, especially in respect of third harmonic. Presumably the power transformers in my audio system did not require the MultiWave correction, and therefore it made them slightly worse. (See Fig 2: MultiWave adds 'distortion' to a pure sine output, the tops now rounded.)

We checked the action of the CleanWave degaussing. This turned out to consist of about 10V of 1.5kHz sine wave in the 235V output, simply switched on for 5 or for 30 seconds and then off, not ramped. This signal is harmless enough, and clearly had a significant, if temporary beneficial effect during listening.

Fig 3 shows the noise and distortion spectrum of my lab mains supply before and after *PPP* noise and distortion spectrum of my lab mains supply. The massive reduction is clear to see, about ten times for the early harmonics and approaching 20 dB at higher frequencies, up to the limit of my test signal sampling transformer.

Conclusions

A winning combination of build quality, experience and innovation has delivered an efficient and highly effective supply regenerator, providing what most others merely promise. In addition to its useful functionality regarding protection and signal loop isolation, there are the mutually filtered output zones and not least the programmable sequenced power-up options, features that may alone justify its purchase in a high quality A/V system context. Furthermore, it met its exhaustive specifications in all the modes tested.

This is an impressive piece of equipment for audiophiles, and is strongly recommended for those unable to install a dedicated power spur from a good quality local electrical power source. On compromised mains supplies, it is almost musically invisible in use, and the gains far outweigh the losses. Highly Recommended.

SPECIFICATIONS & COMPARISONS

PS Audio publishes very detailed specifications. The values relevant to the UK/Europe are reproduced here.

Dimensions (wxdxh)	17x16.5x4ins
Weight	16Kg (35lbs)
Nominal Input Voltage	215-245VAC
Maximum Continuous Load	1500VA
Dynamic Power Delivery	5000VA for 0.5 seconds
Voltage Regulation	+/- 1V AC
Output Distortion	1200VA Resistive load <0.9%
Output impedance	<0.015 Ohm
Noise reduction (all zones)	100KHz-2MHz >80dB
Efficiency @1200VA	Resistive load >80% Reactive load >85%
Input Frequency	45-65Hz
Under voltage limit	175VAC
Over voltage limit	275VAC
Protection Modes	L-N, L-G, N-G
Energy dissipation	2142J
Peak Current surge	84,000A
Max Surge	6,000V
Clamp level	800V
Telco protection	320J, 395V

Points to note, particularly when assessing its capacity for larger power amplifiers, is a low source impedance (below 0.015ohm), a rated output of 1.2kVA (1.5kVA maximum), and a generous 5kVA peak capability for up to half second duration. Noise filtering is claimed to be better than 80 dB from 100kHz to a 2MHz measuring limit, and even with a reactive power amplifier load, efficiency is a high 85%; little is wasted in this device.

I was interesting to compare the performance of the *PPP*'s radical approach against that of a respected linear amplifier type supply. The US voltage PurePower 1050 has 37A peak capacity with 1.6kVA max output, plus the extra of battery back up for 30 minutes from a massive 36V power pack (to be replaced at service intervals) if the mains fails. Its output impedance is rather higher at 0.15 ohm, with consequently poorer 3% load regulation (the *PPP* regulation is 0.15% at this 115V level).