

Bowers & Wilkins

PM1







## **Engineered for the finest moments**

There are times when only music matters. When you want to forget the world and simply lose yourself in sound. The PM1 was built for these moments. Compact and discreet, yet introducing technologies never before seen in any Bowers & Wilkins speaker, it produces a sound so refined that everything else suddenly seems insignificant. True sound. No distractions.



*I never think about beauty.  
I think only how to solve the  
problem. But when I have  
finished, if the solution is not  
beautiful, I know it is wrong.*

Richard Buckminster Fuller

*Form is the external  
expression of inner content.*

Wassily Kandinsky





## **The science of refinement**

In technological design, simplicity is a virtue. It doesn't matter if you're building a supercomputer, a bicycle, or a loudspeaker: the simpler and less complicated the design, the better each individual component can afford to be. The PM1 is a perfect example.

With the PM1, we've taken the principle of the mini-monitor and refined it to its purest essentials. Thanks to the simplicity of its two-way design, we've been able to rethink and improve nearly every component of the speaker, from the construction of the cabinet to the drive units and electronic circuitry within. So while the design of the PM1 might be simple, the stunning richness and detail of the sound it produces is anything but.





**Stuart Nevill trained as a mechanical engineer before joining Bowers & Wilkins. He has spent close to two decades at the Steyning Research Establishment in West Sussex, UK, dedicating himself to the pursuit of true sound. He has been involved in developing new technologies across a broad spectrum of Bowers & Wilkins products. These include the flagship 800 Series Diamond, our partnership with Jaguar producing cutting edge in-car audio systems, and more recently the first ever Bowers & Wilkins headphones, the luxurious P5s.**

#### **How did you approach the development of the PM1 tweeter?**

Our goal with the PM1 was to make a tweeter that had a significantly higher breakup frequency than our standard aluminium ones. We were confident that this would yield a corresponding improvement to performance. We would love to put a diamond tweeter on every product simply for the improvement to performance it offers. But unfortunately it comes at a significant cost. The Carbon Braced Tweeter on the PM1 may not be diamond, but it's the sweetest sounding non-diamond tweeter we have yet produced.

#### **How did you come up with the idea of bracing the tweeter with carbon?**

If you look at a finite element model or a laser scan of a tweeter dome at its first breakup it is fairly clear that the weakness is at the 'skirt' of the dome, so incorporating a stiffening ring in that area was a logical conclusion. We have actually been applying strands of carbon fibre to the skirt of Nautilus™ domes for 15 years but the process was painstaking and the carbon used not terribly stiff, (it couldn't be stiffer or it wouldn't have been possible to apply it!).

We've known about pitch based carbon fibre for some time, it is incredibly stiff. We were lucky that we found someone to wind it into precision rings that fit inside the dome. This is probably an industry first.



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**How does pushing the breakup frequency beyond the range of human hearing benefit the sound that you can hear?**

Any resonance has an audible affect on the response at more than just one frequency, it affects the nearby frequencies, too. By pushing the breakup frequency higher we are pushing all the affected frequencies further above the range of human hearing. An un-braced dome typically goes into breakup at 30kHz, the PM1 dome is pistonic to 40kHz. This results in a marked improvement to the audible sound.

**The PM1 tweeter also uses the same surround material as that used on the 800 Series Diamond. What advantages does that have for the performance?**

The exact choice of rubber is much more critical than most people realise, and we have clever people putting a lot of effort into characterising and refining the rubber materials to give the best performance. The rubber we use on 800 Series Diamond is the ideal compromise between compliance and damping, and was the perfect choice for using on the PM1 tweeter.

The dispersion is related to the diameter of the source, which is the dome and the surround together. By controlling the behaviour of the surround

we ensure that it has minimal output at high frequencies so you only hear the dome, therefore the source size is kept small and dispersion is high.

**What are the benefits of placing the tweeter on top of the cabinet?**

There are a number of good reasons to do this, but the two major ones are that the baffle size should always be kept small in relation with the wavelengths emitted by the speaker and that edge diffraction from a wide baffle causes the radiation of secondary sources that colour the on-axis sound. More simply put the 'tweeter on top' gives you enhanced soundstage depth and a much wider sweet spot. As you will experience when you listen to the PM1.

## Raising the tone



There isn't much our audio engineers don't know about the science of sound. But even they admit that some aspects of acoustics remain mysterious.

For example, you might imagine that any changes made in the frequency range above the limits of human hearing shouldn't have any effect on the sound we actually hear. And yet our experiments with diamond dome tweeters proved otherwise. By raising the break-up frequency far beyond the audible threshold of 20kHz, we created a tweeter that sounded far truer and more natural to the human ear.

With a break-up frequency of 30kHz, our aluminium dome tweeters already

push sound quality well above the upper limits of the audible range. But inspired by what we've learned about diamond, we wanted to see if we could do even better for the PM1. The result is an entirely new type of tweeter dome. By bracing the dome with a ring of filament-wound carbon fibre, we've raised the break-up frequency of aluminium to 40kHz.

Whether or not we unravel all the mysteries of acoustic science, one thing's for certain: the PM1 features the sweetest-sounding aluminium dome tweeter we've yet produced.





**Mike Gough graduated in Physics from Bristol University in 1969. After graduating, he worked at several notable manufacturers as a loudspeaker designer, while also studying part time for a Masters Degree in Applied Acoustics. He joined Bowers & Wilkins in 1989, where his first project was the inaugural 600 Series. In his current role of Product Manager, Mike has overseen the brand's recent successes in the loudspeaker arena including the 800 Series Diamond and now the PM1, with the odd diversion into such products as the first Zeppelin™.**

**What was the driving force behind developing the PM1?**

From an application point of view, we didn't want to have a large range of products catering for home theatre as well as two-channel audio. We decided we wanted a loudspeaker that specialised in stereo and set about concentrating our effort into producing an exquisite small speaker.

**What benefits does a mini monitor have over larger stand mount loudspeakers?**

There are two main benefits. Small cabinets are generally less burdened by cabinet resonance problems than large ones and tend to have superior imaging. Of course, the multi-chamber systems such as 800 Diamond address both these problems and the 'tweeter-on-top' arrangement adopted on many of our speakers improves imaging, but sometimes there has to be a balance struck between the higher output capability of larger drive units, which demand a wider cabinet, and the imaging capabilities of smaller drivers in narrower cabinets.

*Anyone engineering a small speaker must be acutely conscious of the bass extension versus sensitivity relationship and has to be very wary of over-restricting bass extension when it is countered at the other end of the audible spectrum by an extremely good tweeter.*

**What are the specific challenges of designing a small loudspeaker?**

The balancing of small speakers is most definitely an amalgam of science and art. Anyone engineering a small speaker must be acutely conscious of the bass extension versus sensitivity relationship and has to be very wary of over-restricting bass extension when it is countered at the other end of the audible spectrum by an extremely good tweeter. The CM1 had already been well judged in this respect and we followed that general approach.

**Bowers & Wilkins has been using Kevlar for three decades now. How do you continue to ensure you get the most out of our midrange cone material of choice?**

Over the years, we have honed the performance we achieve with Kevlar by experimenting with such things as fibre thickness, weave, resin impregnation, damping compounds and cone geometry. Even then, the formula is not the same for all applications.

**The PM1 features a unique baffle. How was it created, and what acoustic advantages does it have?**

I mentioned imaging before in relation to pure cabinet size, but avoiding sharp corners also helps and the design concept presented by Native, which has hardly altered from first inception, is highly sculpted where the upper part of the baffle meets the cabinet top. This rounded form is difficult to achieve if you also want a structure that is acoustically inert. The "head" unit of the 800 Diamond was the inspiration, but that is far thicker in parts than we could accommodate in a small full-range cabinet. In the end, we adopted a two-layer approach. The outer, visible material is a thermoset polymer, which can readily be finished to the required standard and is very stiff. On the inside is applied a layer of a more lossy compound that adds mechanical damping as well as mass to improve the inertness of the composite structure.

Leading from the front



Where we lead, others eventually follow. It was back in 1974 that Bowers & Wilkins first discovered Kevlar's® unique ability to absorb the standing waves that can cause resonance in other midrange cone materials. Nowadays, you'll see Kevlar cones in a number of high-end speakers. But even as others adopt our technologies, we continue to innovate. And we see no reason to stop today.

For the PM1, we've enhanced the resonance-absorbing properties of Kevlar still further with a unique, entirely new feature: the anti-resonance plug. Constructed from polymer foam, the mushroom-shaped device soaks up resonance like a sponge while also reducing cone break-up, creating unparalleled clarity and detail in the midrange. Kevlar just got better. And the bar for other speakers just got raised even higher.

# Deep breath

If you want to generate a big sound from a small speaker you're going to need a decent set of lungs. The PM1 has the best breathing apparatus in the business, thanks to a special piece of proprietary Bowers & Wilkins technology we call Flowport™.

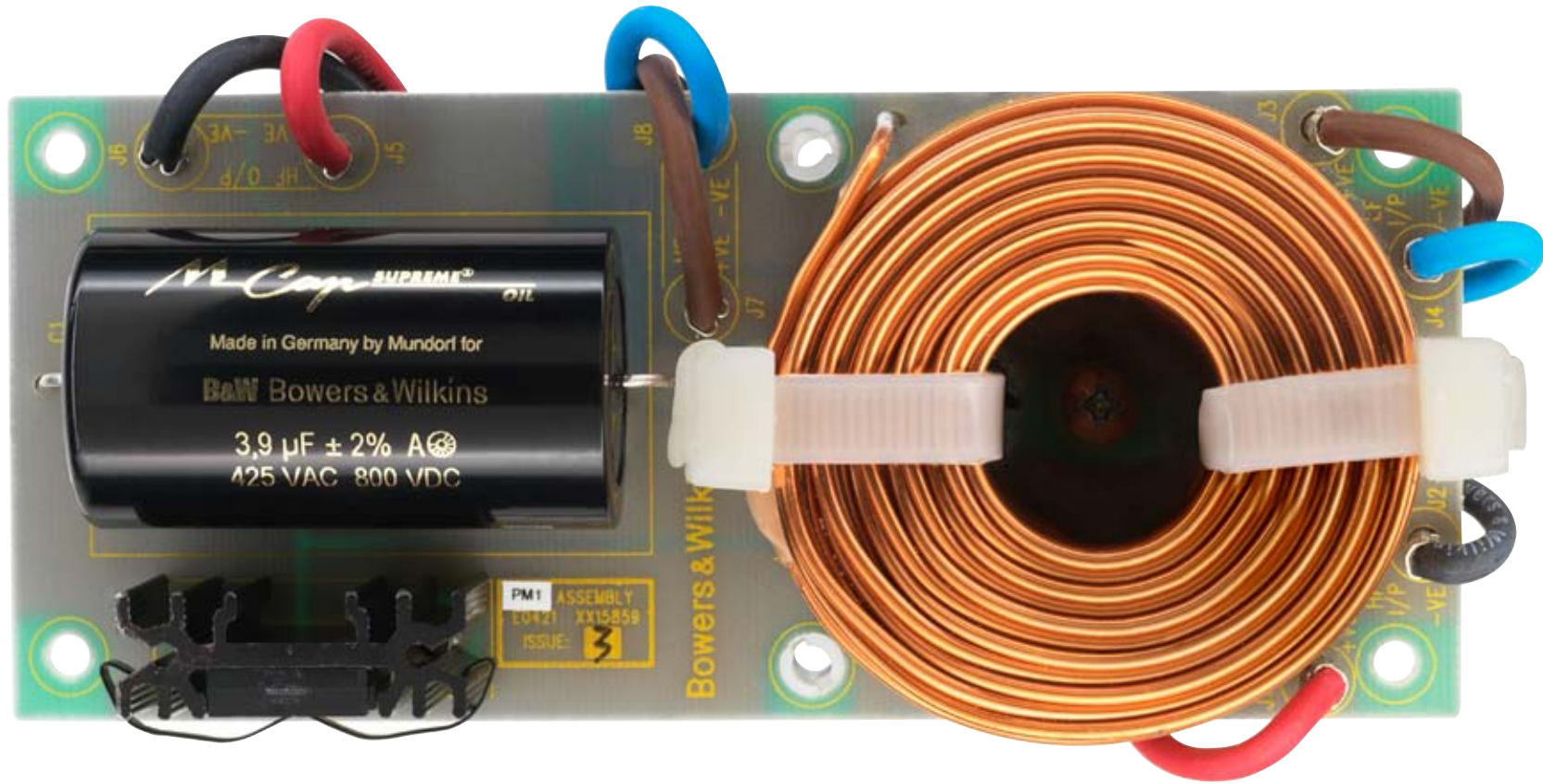
Flowport helps the PM1 compensate for its relative lack of internal space by regulating airflow in and out of the speaker. It does this in a way that minimises turbulence and extraneous noise, so bass remains tight and well timed even at louder volumes.

Just like a golf ball, the dimples covering the exterior of the vent create little eddies of air, cushioning airflow across the surface of the Flowport and reducing the turbulence that produces unwanted "chuffing" noises. With Flowport, you get smooth air in, and



Pure and simple

A speaker is only as good as the electronic signal it receives. The trick here is to keep things simple: an over-complicated crossover risks losing some of the integrity of the signal as it passes from the amplifier to the drive units. Thanks to the PM1's purist two-way design, we've been able to use the simplest possible crossover, featuring some of the high-quality components you'll find in our flagship 800 Series Diamond.





## Rock solid

The measure of any speaker cabinet is its strength and rigidity. The aim is to create a totally still, inert structure: to stamp out the slightest hint of vibration that can cause resonance within the speaker and colour the sound it produces. With a speaker as powerful and finely tuned as the PM1, cabinet bracing is even more important.

Pick up a PM1, and you can tell straight away that you're holding a reassuringly solid speaker. What's less obvious is the internal architecture that makes it so. Just like our flagship 800 Series Diamond, the PM1 uses our Matrix™ bracing system, a grid of extremely strong interlocking panels that keep the speaker rock-solid and immobile. So all you hear is the drive units, and not the cabinet that surrounds them.



## Rounded performance

When you look at the flagship loudspeakers in the Bowers & Wilkins 800 Series Diamond range one thing immediately strikes you: the beautiful curvaceous head units. The PM1's curved baffle echoes that shape, and for good reason: it smoothly disperses the sound around the speaker, helping to create a solid, three-dimensional image.

Coupled with the placement of the tweeter on top of the cabinet, this significantly reduces the baffle area surrounding the drive units. This produces an enhanced depth of soundstage, and a wider sweet spot.

The choice of materials helps to render the cabinet inert, which is vital on such a compact loudspeaker. The resulting performance is breathtaking in its ability to reproduce the audio signal, particularly when it comes to rendering the natural timbre of voices.



## Object of desire



At Bowers & Wilkins we understand that for many people audio quality isn't the only consideration when deciding upon a loudspeaker. And while we would never place design considerations above acoustics, we appreciate that the look and feel of a loudspeaker is important. But we don't need to explain ourselves; one look at the PM1 should be all you need to understand.

The Nautilus tube-loaded tweeter on top, the curved baffle, the Kevlar drive unit, are all included for technological, audio-related reasons. But they also come together visually, to create an aesthetically pleasing whole.

Add to that the Mocha Gloss wood panels and matching stand, and we're confident that the PM1 is not only the most refined sounding small speaker we have ever produced. It's also one of the most desirable.



**Morten Warren is the founder and president of Native, a product design firm with an international reputation for award-winning, world-class product, interaction and brand experience design. His work for Bowers & Wilkins includes the iconic Zeppelin Air and Zeppelin Mini, the flagship 800 Series Diamond and the luxurious P5 mobile hi-fi headphones.**

**Could you tell us about your inspiration for the PM1?**

Ever since we designed the 800 Series back in the late '90s we were always fascinated by how we could create more shape and form from a cabinet. We know from the development of the head unit of the 800, that a tweeter performs very, very well in a domed spherical surface. So when we had the opportunity to design a very compact high-performance loudspeaker, we wanted to re-leverage all of that learning from the 800 head and see whether we could build a very compact speaker that benefitted from some of those acoustic features. And I think we managed to achieve it with the PM1.

**How did you balance the requirements for a loudspeaker to be a sound tool and also a beautiful piece of furniture?**

The sound comes first. We know the shape and the form influence how a loudspeaker performs, so I think that is first and foremost. And then the real art is to make that object work aesthetically. A lot of effort has gone into this design; so it is quite harmonious in a domestic living environment, but at the same time offers very high performance. Something that is always intellectually intriguing about designing a loudspeaker is that you have to find a balance between the complete freedom to design something that is beautiful, against the need to ensure that it is actually going to sound great.

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**What challenges did you come across with the PM1 and how did you overcome them?**

The main challenges were around the front and top of the PM1; the moulded baffle. This is an unusual process for loudspeakers, because it uses an incredibly dense material that is then bonded to the side panels, which have been specially made for Bowers & Wilkins using hand-picked veneers and cross-plied at certain angles.

Also, we have used six dissimilar materials in the construction of the PM1. These come together to create an incredibly robust durable construction that has very, very good acoustic properties. When you build a loudspeaker from many dissimilar materials it can have quite a lot of acoustic benefits in the way that the cabinet resonates and performs.

**How do you rate the success in the design?**

I am certainly never 100 percent happy with anything I design. I am always restless in wanting to improve anything that comes my way. But I think it's a good-looking design and that the general proportions have worked well.

**How closely did you work with the in-house technology team at Bowers Wilkins?**

Very, closely. It is a very long-standing relationship, which goes back many years. I think the best relationships naturally allow a lot of open debate. You know a lot of persuasion and interaction between the Bowers & Wilkins acoustic team and myself, where we are constantly trading off what I want, what they want, and it's a very healthy relationship. There are times when we can throw punches. But the most important aspect is that we are all trying to aim for the same thing: to make an exquisitely well manufactured, beautiful sounding loudspeaker that is worthy of the Bowers & Wilkins brand. And I think that over the years, together, we have produced some of the most successful loudspeaker ranges in the world.





**Society of Sound** So that's it. Or is it? At Bowers & Wilkins, the pursuit of perfect sound continues. For over 40 years, we've been dedicated to creating a loudspeaker that neither adds nor takes away from the recorded sound. In the process, we've become a world leader, developing groundbreaking speakers like the PM1. It's a passion. But we're not alone. There are others – musicians, technicians, critics, customers – who are as dedicated as we are. And now we're coming together to share music, knowledge, insights and our love of sound.

You can be a part of this network too. Come to [www.bowers-wilkins.com](http://www.bowers-wilkins.com) to find out more and to join the Society of Sound.

## Capturing the finest moments

Playing a complete performance to a full house adds an element of creative tension to a recording, which can never be simulated in a studio. LSO Live only release the London Symphony Orchestra's finest moments, many of which are available through Society of Sound. The results are breathtaking. Conductors love it too. Sir Colin Davis shudders at the thought of doing anything other than live recordings. Valery Gergiev insists that all his recordings are live. Rostropovich initially didn't want to record live, but was astonished at a playback of the master: 'It's miracle – how we do that?'





# PM1

Technical features	Nautilus tube loaded tweeter with carbon fibre reinforced aluminium dome Kevlar cone bass/midrange Flowport		
Description	2-way vented-box system		
Drive units	1x ø25mm (1in) reinforced aluminium dome high-frequency 1x ø130mm (5in) woven Kevlar cone bass/midrange		
Frequency range	-6dB at 42Hz and 60kHz		
Frequency response	48Hz–22kHz ±3dB on reference axis		
Dispersion	Within 2dB of reference response Horizontal over 60° arc Vertical over 10° arc		
Sensitivity	84dB spl (2.83V, 1m)		
Harmonic distortion	2nd and 3rd harmonics (90dB, 1m) <1% 110Hz - 22kHz		
Nominal impedance	8Ω (minimum 5.1Ω)		
Crossover frequency	4kHz		
Recommended amplifier power	30W–100W into 8Ω on unclipped programme		
Max. recommended cable impedance	0.1Ω		
Dimensions	PM1	Height	331mm (13in)
		Width	191mm (7.5in)
		Depth	250mm (9.8in) cabinet only 293mm (11.5in) including grilles and terminals
	Stand	Height	620.5mm (25.6in) excluding spikes
		Width	268mm (10.6in)
		Depth	300mm (11.8in)
Net weight	9.3kg (20.5lb)		
Finishes	Cabinet	Real wood veneer Mocha Gloss	
	Grille	Black	



## Bowers & Wilkins

[www.bowers-wilkins.com](http://www.bowers-wilkins.com)

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