

Luxury tools

Comparison of small-diaphragm condenser microphones, part II for models over 500 euros

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Here it is, as promised, the second part of the extensive tools 4 music microphone comparison. A full 15 of the total of 21 candidates fall below the limit of 500 euros set by us, and have already been compared with one another in the previous issue. This leaves another six microphone pairs. Here we go...

This time the pricing, based on retail prices which we verified via the Internet, begins at 599 euros for two beyerdynamic MC 930 microphones. A pair of AKG 451B mics costs just under 700 euros, and a pair of Sennheiser e914 and Shure KSM137 microphones can be obtained for 718 and 755 euros respectively. Two Audix M1250 mics for 796 euros come next, while a Neumann KM 184 pair is at the upper end of the spectrum, at 1,099 euros.

AKG C 451B

The C 451B is a true AKG classic which was re-included in the product program by the Austrians some time ago, however without the possibility of changing the capsule. The silver "rod", 16 cm long, and as thick as your thumb, is impressively robust with faultless workmanship, and achieves good measurement results particularly for the equivalent sound pressure level. However, this applies to only one microphone of the stereo pair! The other microphone has an excessively high level of self-noise, possibly due to a defect in the preamplifier or a significant component discrepancy. Unfortunately this also affects the similarity of the pair. Between 430 and 4,300 Hz, the measurement curves for rear attenuation remain below the magic -20 dB line. For rear attenuation, this is a very good result, even though the curves exhibit variations with peaks at 800 and 2,000 Hz. The sensitivity and transient fidelity values are in the average range for the microphones tested; for the maximum sound pressure level, the C 451B is in last place. However, here it must be taken into account that the low assessment for pair matching is probably attributable to a preamplifier in one of the microphones that is not functioning within normal parameters – whereas an intact pair might have achieved a better evaluation and rank-



A classic reappears in the product program: However the AKG C 451B does not offer the possibility of changing the capsule.



The Audix M1250 (on the right) is not much larger than one's little finger; the capsule and miniature pre-amplifier are housed in a sturdy metal tube with black finish.

ing. (Editor's note: Since the German distributor, Harman Pro/Heilbronn, basically declines to participate in comparison tests, we could not – as we usually would – order a corresponding replacement for the purpose of checking the measurement results. The models tested here are new microphones, made available to us through the retail trade, which would have been sold as such.)

Audix M1250

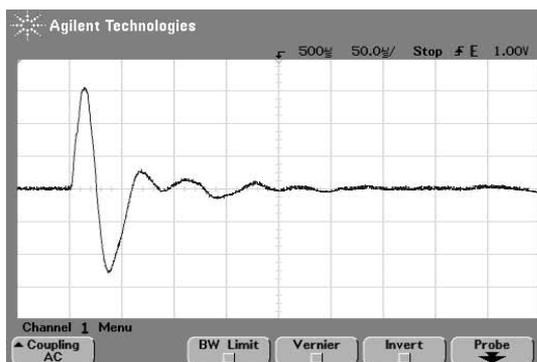
The Audix microphones coming to us are “made in the USA”, or more specifically in Wilsonville, Oregon. In addition to the dynamic stage microphones of the OM and D series that are now quite well-known, the Audix product portfolio also includes several condenser models, such as the M1250. As far as its dimensions are concerned, it is the only model tested which we have to classify as a miniature microphone. It is not much larger than one's little finger; the capsule and miniature

pre-amplifier are housed in a sturdy metal tube with black finish. A suitable connection cable is provided with the microphone to connect the mini XLR output to a standard XLR connector. The measured frequency response of the M1250 is one of the most linear in the test: It is almost perfectly straight over the entire mid-range, before beginning a slight rise at 4 kHz, which reaches a peak of +4.3 dB at 9 kHz.

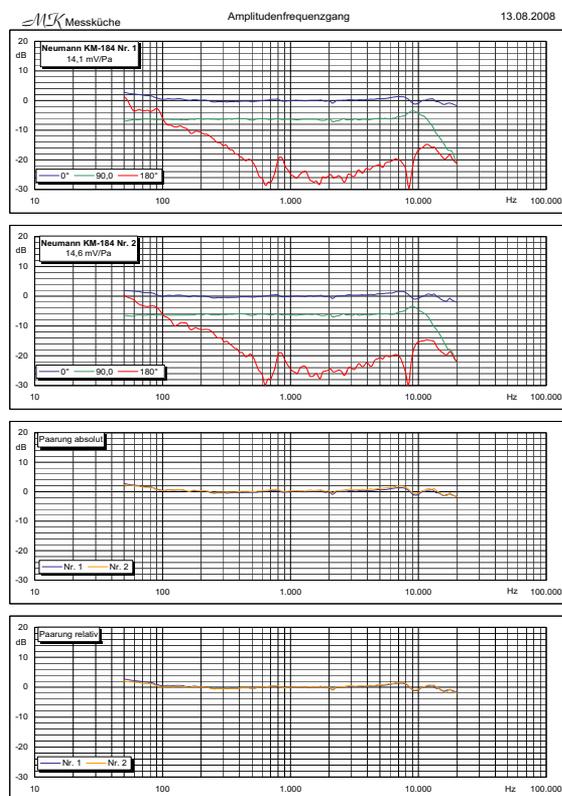
The measurement curve for lateral sound sources located at an angle of 90 degrees from the front of the microphone meets the -6 dB requirement for the cardioid characteristic over an extended range, and the 180 degree rear attenuation also looks very promising: From 550 Hz to around 8,000 Hz the curve lies below the -20 dB mark, apart from a small interruption at around 830 Hz. However, the attenuation then becomes rapidly less pronounced, so that at 10 kHz the microphone has an almost omnidirectional characteristic. The similarity of the pair of individual microphones is average for the models tested, as is the maximum sound pressure level,

Measurement diagrams

Unfortunately, due to space constraints it is not possible to print all of the measurement diagrams. We have therefore selected only two representative diagrams here. For anyone who would like to see more, all of the frequency and transient responses for the test (including those from the first part of the test reported in the previous issue) can be found at www.tools4music.de in the “Mehrwert” section. A table with the measured values obtained for the equivalent sound pressure level, sensitivity and maximum sound pressure level can also be found there.



The transient response recorded by us for the second-place Shure KSM137: Two clean half-waves indicate the back and forth oscillation of the diaphragm in response to a single sound pulse, while the amplitude and number of subsequent oscillations are negligibly small.



Measured frequency responses of the test winner Neumann KM 184: Except for slight variations in the high-frequency range, the 0 degree frequency responses (shown in blue) exhibit ideal linearity. The bass boost below 100 Hz is probably attributable to the proximity effect, and the slight dip at 2100 Hz shows the influence (reflection) of the mic clamp. The green curves (for sound from lateral sources located at an angle of 90 degrees from the front of the microphone) are just under -6 dB for a wide range of frequencies, and the red curves are below -20 dB; thus here the microphones adhere precisely to the requirements for a cardioid directional characteristic.

which in reality deviates considerably from the optimistic specification of the manufacturer (150 dB SPL @ 0.5% THD!). The values determined for self-noise and sensitivity for the Audix M1250 are among the average for the microphones tested.



Third place in both the Performance and Price-Performance categories: The beyerdynamic MC 930.

beyerdynamic MC-930

The MC 930 from the beyerdynamic company turns out to be a microphone just under 13 cm long, with high-quality workmanship and an extremely linear frequency response in the important mid-range. Not until the high-frequency range, at 10 kHz, is there a small rise of 4 dB. The rear attenuation achieves “cardioid conditions” between 550 Hz and 2 kHz, and even in the high-frequency range we are happy to say it does not rise above -10 dB! The manufacturer attains good to very good results for self-noise, transient fidelity and sensitivity (the highest among the microphones tested!); the microphone ranks lower only in the case of the maximum sound pressure level.

Neumann KM 184

The Neumann KM 184, which is to be categorized as having a sophisticated professional standard, achieves top values for almost all categories and measurements, and thus represents the reference against which the rest of the test participants must be measured. What makes the Neumann microphones so special? First, the quality of the workmanship: In order to ensure the best possible shielding from interference, the circuit board is equipped with four springy copper slide contacts that all have contact with ground; when assembled they provide reliable electrical contact with the microphone housing, which is approximately 10.5 cm long.

Cardioid – what is that?

In response to several inquiries and differences of opinion regarding the evaluation of the rear attenuation of the test microphones, here again is the precise definition of the cardioid directional characteristic: The directional characteristic is considered to be cardioid if sound from lateral sources located at an angle of 90 degrees from the front of the microphone is transmitted at a level 6 dB lower than sound from sources in front of the microphone. In theory, sound from sources to the rear (at an angle of 180 degrees from the front of the microphone) should be completely eliminated by a cardioid capsule; in practice, attenuation of >20 dB is regarded as satisfactory. As illustrated in our measurement diagrams, the directional characteristic of a microphone is always dependent upon the frequency and – depending upon the model – is often effective only in the mid-range. Due to the construction parameters, for basses and high frequencies the directional effect is often much less pronounced – the cardioid characteristic becomes more and more omnidirectional.

The SMD board makes an outstanding impression. The first converter stage directly connected to the capsule has been sealed by Neumann with a black coating – this helps to guard against cracks or malfunctions in the case of high air humidity (due to fluctuations in atmospheric conditions) and perhaps also protects various fine points of the circuitry from curious glances – who knows?

With regard to frequency responses, the two KM 184 microphones likewise exhibit no weak points: Except for a very slight 1 dB rise between 7 and 8 kHz and a similar dip at just under 10 kHz, the

Info

www.ake.com
www.beyerdynamic.de
www.neumann.com
www.sennheiser.de
www.shure.de
www.trius-audio.de (Audix)

tools 4 music
PERFORMANCE
TESTSIEGER

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PREISWERT
TESTSIEGER



Congratulations: The Neumann KM 184 set is the winner of this comparison test.

“We can participate too!”

Yes, usually there are no AKG microphones in this type of comparison test, since the German distributor, Harman Pro/Heilbronn, declines to participate in such tests. The inclusion of AKG microphones in the previous issue of tools 4 music as well as in the present test is due to the fact that the corresponding models were made available to us through the retail trade.



The Sennheiser e914 exhibits clear emphasis of specific frequency ranges (see text).

measurement curve is perfectly linear. The rear attenuation likewise turns out to be excellent, and the two microphones are also leaders in terms of self-noise and similarity of the pair. The measurements of maximum sound pressure level and transient fidelity also yield very good results. Only in terms of sensitivity are the Neumann mics not in first place, although here too they perform better than average.

Sennheiser e914

The two e914 mics are 16 cm long and have rotary pre-attenuation and low-cut filter switches, each with two settings. There is no fault to be found with the workmanship and sturdiness; however, the two individual microphones exhibit U-shaped frequency responses, with strong emphasis of the basses and lower mids. Transmission by the e914 is also by no means linear for high frequencies – for each microphone there is a 6 dB boost that begins at 2 kHz and ends quite abruptly just above 10 kHz, with a dip at 9 kHz. The rear attenuation achieves “cardioid conditions” between 500 Hz and 3 kHz, a good result overall. In terms of the measured maximum sound pressure level, both microphones attain above-average values, close to those specified by the manufacturer. However, the transient responses each exhibit one pronounced subsequent oscillation, followed by several small oscillations.

Shure KSM137

Our last candidate, the Shure KSM137, which is 12 cm long, is impressive due to very good frequency response curves. Except for a slight emphasis of the bass below 100 Hz and a small 2 dB boost in each case at 10 kHz, the curves are linear. The rear attenuation exhibited by the two individual microphones, which remains well below the -10 dB mark even at high frequencies, is among the best results for the microphones tested. Excellent marks are likewise achieved for self-noise, pair similarity and transient response.

Only in the case of maximum sound pressure levels do the microphones fall below the average for the test; however,



The Shure KSM137 achieves a good second place – only one point behind the winner in the Price-Performance category.

FOLLOW-UP

Wolfgang Fraissinet, President of Marketing/Sales at Georg Neumann GmbH:

“We are naturally pleased that this very detailed, objective test confirms the qualities of the Neumann series 180 miniature microphones and their role as a reference standard. It only remains to be mentioned that the KM 184, and miniature microphones with five other directional characteristics, are now also available from Neumann in a completely digital version. The A/D converter integrated directly into the microphone in the digital version eliminates the need for lengthy experimentation with external converters and preamps, and the Neumann sound is captured directly on the hard disk with optimal quality.”

Klaus Kirchhöfer from beyerdynamic: *(At the request of the manufacturer, these comments have been taken from tools 4 music, issue 5/2006.)*

“Many thanks for the multi-faceted test! Unfortunately, the test raises almost as many questions as it purports to answer: You have performed some measurements outside – how did you control background noise? For the maximum level measurement a 1 kHz sinusoidal signal was used – how was this generated? What was the distortion factor (THD) of the sound source itself? Microphones were awarded more points for an accompanying wooden container or case than for a bag – do rental companies or musicians want to pile up boxes next to the stage in the microphone case? A high sensitivity can be useful for example for acoustic guitars or choir recordings – but how will a small compact mixer respond if I decide to clamp the microphone to a snare drum? A cardioid directional characteristic is supposedly defined among other things by a rear attenuation of at least 20 dB – what was that well-known vocal microphone that you like to use for testing sound system loudspeakers? I know that people, including most microphone users, naturally wish to have simple solutions (otherwise

the measured values correspond closely with those specified by the manufacturer.

Finale

Despite the considerably higher selling price in comparison to its competitors, the Neumann KM 184 is the winner in both the Performance and Price-Performance categories, with the Shure KSM137 a close second. In the test, no weak points are exhibited by the traditional Berlin microphone manufacturer, which thus impressively demonstrates its special position with regard to the quality of microphone construction. Shure achieves second place with the KSM137 – a microphone which is impressive particularly with regard to linearity, very good rear attenuation and low self-noise. With the MCE 930, beyerdynamic attains a respectable third place in both categories, followed by the Sennheiser e914, the miniature microphone M1250 from Audix and the AKG C 451B, which have results very close to one another in both categories.

In addition, it should be noted that the criteria for evaluating the microphones, as well as the measuring setup, were identical for both parts of this comparison test (see tools 4 music, issue 5/2008). The results can therefore also be used to assess the qualitative differences between models with selling prices above and below 500 euros.

Info

Selling price (determined by Internet research in October 2008)

AKG C 451B	333 euros (individually)	699 euros (pair)
Audix M1250	398 euros (individually)	796 euros (pair)
beyerdynamic MC 930	333 euros (individually)	599 euros (pair)
Neumann KM 184	649 euros (individually)	1,099 euros (pair)
Sennheiser e914	359 euros (individually)	718 euros (pair)
Shure KSM137	375 euros (individually)	755 euros (pair)

tabloids such as the [German] Bild would not have such high circulation figures); however, in the final analysis I consider it to be at least questionable to reduce such obviously complex material to a simple winners' platform! If you had left it at descriptions (as far as I am concerned including measurements, although their information value is quite limited), with perhaps a few more application examples, it could have been not only a more well-rounded but also a more informative test. Now which musicians' magazine is actually the best?"

Matthias Höbeler from the German Audix distributor Trius:

"In retrospect, in considering the microphones tested it seems to us that for our own selection, the Audix SCX-1 would have been more suitable for comparison with the KM 184, for example. In deciding upon a special solution with the MICRO series we have gone somewhat beyond the technical framework of this test. However, this introduces variety to the small-diaphragm group, which is also good. With regard to the M1250, in conjunction with the evaluation and application information, I would also like to mention that this series is made with interchangeable capsules; in addition to the cardioid directional characteristic, hypercardioid, omnidirectional and lobe-shaped/supercardioid characteristics are also available. With the M1280 version (like-wise with a diameter of 12 mm, but with a length of 80 instead of 50 mm), a microphone is available with an extended frequency response down to 40 Hz, instead of 80 Hz as is the case with the M1250. The M1250 is also available in white. As well, every conceivable attachment accessory can be obtained, from fine floor stands for mounting, to goosenecks, to various drum clamps and elastic mini-suspensions. In addition, the M1255 MICRO version is optimized with a different sensitivity for larger microphone distances (e.g. for room, overhead and ambient applications). Finally, there is the M1244 without the RFI protection circuit, with a maximum sound pressure level of 144 dB, for a 15 percent lower selling price. The MICROS are truly an extensive, universally applicable series, since they can be used for everything from speech to classical to recording rock drums. Thank you for the test. In addition to positive, surprised feedback from first-time users in terms of the sound, we are very pleased to find here that a mi-

crophone which is technically so different and more flexibly designed can compete so well."

Bernd Friedel, Director of Sales & Marketing, Shure Distribution

GmbH: *(comments taken from tools 4 music, issue 5/2006)*

"It is wonderful that we could participate in the small-diaphragm microphone comparison with two Shure KSM models simultaneously. Of course we are especially pleased to be among the winners for both price categories. It is clear that the strengths of the KSM109 as well as the KSM137 are the low-self noise and the precise, high-fidelity transmission, which are also perfectly reflected in the test."

Stephan Scherthan, Industry Team Manager for the Music Industry at Sennheiser electronic GmbH & Co KG:

"In the development of the e914, tested in detail here, the microphone was optimized not for linearity, but for the application. The criticized frequency response boost of the highs was thus implemented deliberately and purposefully, in order to lend the e914 a significantly greater presence and clarity for the recording of acoustic instruments (e.g. guitars) or for use as a percussion overhead mic. The e914 was developed "in the field" as it were. During the development of the microphone we implemented various frequency responses, which we compared with one another in intensive application-related listening tests for studio and live applications. We deliberately decided upon this application-oriented sound and thus gave a clear priority to the sound as opposed to measurements. Unfortunately, in the present test – probably for the purpose of achieving comparability – the quality of a microphone is equated with the linearity of its frequency response curve. This may be valid for microphones in the field of measurement technology. However, for the stage and studio, one also needs microphones with a character and sound as is the case here with the e914. Microphones that have a highly linear frequency response are likewise included in the Sennheiser portfolio, in the group of MKH microphones."

We compare

It should be kept in mind that in the test the maximum values determined here – for example in the measurement results – do not mean that a model with zero points is unusable or that a candidate with ten points represents ultimate perfection. These values are only relative with regard to this test. Thus a value of zero points for a category means only that this is the lowest result in this test; it is not an absolute value. The poorest result in the test can often still represent a good value in practice.

In the category "Features and accessories supplied with the microphone" points are awarded in accordance with the proven procedure: One point per item! Exceptions marked with an asterisk (*) are explained below.

Low-cut & pad switches: Due to the two settings for the low-cut filter and pre-attenuation, the AKG C 451B, Sennheiser e914 and Shure KSM137 each receives 2 points

Clamp: The Neumann KM 184 and Audix M1250 each include two additional clamps for attaching the microphones to the connecting cable: 2 points

Spider suspension mount: The MCE 930 from beyerdynamic has replacement rubber rings for the accompanying suspension mount: 2 points
Transport container: A simple gig bag receives one point, a case or wooden container two points, and a plastic or metal transport case three points

Measurements

As usual in tools 4 music comparison tests, the focus is on the two main assessment tables. Together with the customary criteria such as sturdiness, quality of workmanship and features, the measurements carried out are responsible for most of the points awarded. The following are the parameters measured by us.

Equivalent sound pressure level: This provides information concerning how much self-noise the capsule produces in combination with the downstream internal preamplifier. To obtain this measurement, each microphone is placed in a "noise chamber" – an absolutely silent sound-proof area acoustically completely insulated from the environment – and its output signal, corresponding to its self-noise, is measured. The lower the equivalent sound pressure level turns out to be, the better the microphone.

Sensitivity: This indicates how sensitively the microphone responds to sound. A high sensitivity means a high output level, so that the preamplifier of the subsequent mixing console channel need not be turned up so high, and possible noise interference in the cable route will be less pronounced. For the measurement, the front of each microphone is exposed to a 1 kHz test tone with a defined sound pressure (1 pascal), and the level of the electrical

signal at the output is determined. The load is provided by a realistic input impedance of one kilohm. Here deviations from the manufacturers' specifications may be partially attributable to the fact that these were determined without a terminating impedance (no-load sensitivity).

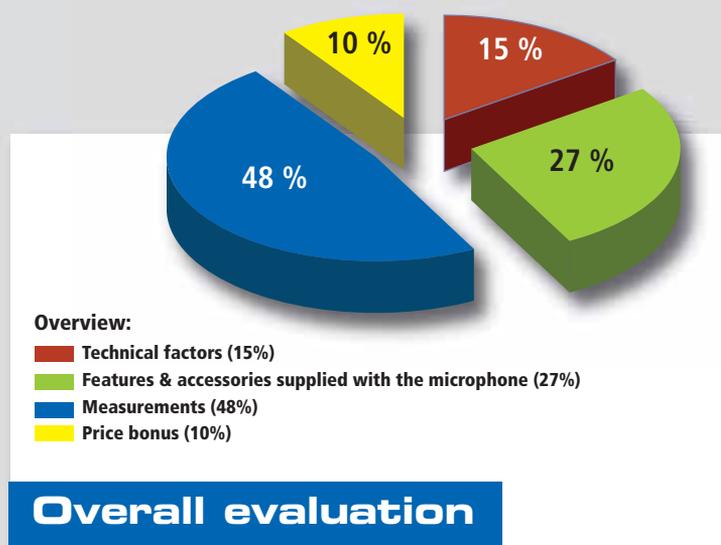
Maximum sound pressure level: Each microphone is subjected to an increasingly loud 1 kHz test tone, until the distortion factor meter connected to the output indicates 1 percent THD. Load: Likewise one kilohm.

Frequency responses: These are measured in a nonreflecting environment outdoors. Frequency range of the sweeps: 5 Hz to 20 kHz; the distance from the microphone to the sound source is 50 cm. In order to exclude reflections from the ground, the microphones are oriented toward a sound source (loudspeaker) resting on the ground. Unlike the method used by some manufacturers, who for this measurement like to let the microphone dangle from above on a cable, we systematically employ the realistic approach of using the accompanying clamps or suspension mounts with a stand. This results in slight reflections, recognizable in the diagrams in the form of small irregularities, primarily in the range between 1,000 and 3,000 Hz. In order to examine the "cardioid" directional characteristic, the frequency response is recorded for sound sources located laterally (at 90 degrees) and to the rear (at 180 degrees), with the microphones turned accordingly.

Transient response: Each microphone is subjected to a single transient-type sound event in the form of an explosive sound (an electrical spark discharge). A storage oscilloscope records the resulting electrical output signal of the microphone. An ideal transient response consists of two clean, symmetrical half-waves without subsequent oscillations, documenting the theoretically single deflection of the diaphragm forward and then back again. The fact that this differs in practice is shown by the actual transient diagrams obtained, which in some cases indicate several subsequent oscillations.

Calculation of the price bonus for microphone models over 500 euros (where the maximum number of points corresponds to 10 percent of the Performance evaluation):

- 1,099 euros or more: 0 points
- From 1,000 to 1,049 euros: 1 point
- From 950 to 999 euros: 2 points
- From 900 to 949 euros: 3 points
- From 850 to 899 euros: 4 points
- From 800 to 849 euros: 5 points
- From 750 to 799 euros: 6 points
- From 700 to 749 euros: 7 points
- From 650 to 699 euros: 8 points
- From 600 to 649 euros: 9 points
- Up to 599 euros: 10 points



Technical factors

Manufacturer	AKG	Audix	beyerdynamic	Neumann	Sennheiser	Shure
Model	C-451 B	M-1250	MC-930	KM-184	e-914	KSM-137
Sturdiness (0 to 5 points)	4	4	4	4	4	4
Workmanship (0 to 5 points)	2	4	4	5	4	4
Metal housing	1	1	1	1	1	1
Internal transformer	0	0	0	0	0	0
Drop test (no damage 4, slight dents 2, impaired/non-functioning 0)	4	4	4	4	4	4
Subtotal (max. 16 points)	11	13	13	14	13	13

Measurements

Manufacturer	AKG	Audix	beyerdynamic	Neumann	Sennheiser	Shure
Model	C-451 B	M-1250	MC-930	KM-184	e-914	KSM-137
Self-noise (equivalent sound pressure level), 0 to 10 points	8	4	8	10	4	9
Sensitivity, 0 to 5 points	3	2	5	3	3	3
Maximum sound pressure level, 0 to 10 points	1	5	2	9	7	3
Rear attenuation at 180 degrees, 0 to 10 points	6	8	6	10	5	9
Linearity of frequency response, 0 to 5 points	3	3	4	5	2	4
Transient fidelity, 0 to 5 points	3	3	4	4	1	4
Similarity of the pair, 0 to 5 points	0	3	3	5	3	5
Subtotal (max. 50 points)	24	28	32	46	25	37

Features & accessories supplied with the microphone

Manufacturer	AKG	Audix	beyerdynamic	Neumann	Sennheiser	Shure
Model	C-451 B	M-1250	MC-930	KM-184	e-914	KSM-137
On/off switch	0	0	0	0	0	0
Low-cut switch (*)	2	0	1	0	2	2
Pad switch (*)	2	0	1	0	2	2
3/8" adapter sleeve	1	1	1	1	1	1
Clamp (*)	1	2	0	2	1	1
Spider suspension mount (*)	0	0	2	0	0	0
External windscreen	1	1	1	1	1	1
Stereo rail	1	0	0	0	0	0
X/Y extension	0	0	0	0	0	0
External pop screen	0	0	0	0	0	0
Interchangeable capsule	0	0	0	1	1	0
Interchangeable capsule included	0	0	0	0	0	0
Directional characteristic converter	0	0	0	0	0	0
Presence boost adapter	0	0	0	0	0	0
Internal battery	0	0	0	0	0	0
Gig bag (*)	0	1	0	0	1	0
Case/wooden container (*)	0	0	0	2	0	0
Transport case (*)	3	0	3	0	0	3
XLR connection cable	0	1	0	0	0	0
Printed operating instructions/data sheet	1	0	1	1	1	1
Downloadable operating instructions/data sheet	1	1	1	1	1	1
(*) for notes, please see text						
Subtotal (max. 28 points)	13	7	11	9	11	12

Manufacturer	AKG	Audix	beyerdynamic	Neumann	Sennheiser	Shure
Model	C-451 B	M-1250	MC-930	KM-184	e-914	KSM-137
Technical factors (max. 16 points)	11	13	13	14	13	13
Measurements (max. 50 points)	24	28	32	46	25	37
Features & accessories supplied with the microphone (max. 28 points)	13	7	11	9	11	12
Performance evaluation (max. 94 points)	48	48	56	69	49	62
Price bonus (max. 10 points)	8	6	10	0	7	6
Price-Performance (max. 104 points)	56	54	66	69	56	68

Overall evaluation