



A-T 50 Series Microphones

White Paper

Development of the 50 Series began by focusing on purity of sound.

Condenser microphone design principles are well-established; they have been the subject of extensive theoretical analysis and development for many years. However, the Audio-Technica engineers working toward a “purity of sound” understood that there are still many areas of condenser microphone performance that can be improved upon.

New and innovative condenser element technologies have certainly been key to the development of the 50 Series – and one of the most demanding areas of the process – but they have not been the only factor. To provide “purity of sound” it was necessary to handle other critical development areas as well.

Based on Audio-Technica’s long, successful history of bringing new microphone technologies to market – from design and development to the establishment of precise production process controls – innovative rectangular microphone elements, supportive electrical circuitry, and overall mechanical improvements were all incorporated into the 50 Series microphones. These microphones are the answers from Audio-Technica engineers to the question, How do we provide our microphone customers with “purity of sound”?

• AT5040 Cardioid Condenser Studio Vocal Microphone

The AT5040, our first 50 Series product, represents a milestone in condenser microphone design by incorporating an innovative, four-part rectangular element – Audio-Technica’s largest ever – along with transformerless circuitry that includes only the essential components to provide a true, pure sound with a self-noise of only 5 dB, all within a robust, precisely designed body.

• AT5045 Cardioid Condenser Studio Instrument Microphone

The AT5045, our second 50 Series product, also features an innovative element – this the largest single diaphragm Audio-Technica has ever created – along with transformer-coupled circuitry honed to the essentials, boasting a max SPL spec of 149 dB, and all incorporated into a solid, slim, and precisely designed stick-type body.

• AT5047 Highly Versatile Transformer-Coupled Cardioid Microphone

The AT5047, our latest addition to the 50 Series, provides an exceptionally wide dynamic range of 142 dB and uses the same four-part element as the AT5040, but here it is matched with transformer-coupled circuitry to give the microphone greater versatility.

Microphone Element

We knew from the outset that to provide “purity of sound” it would be essential to use a large-diaphragm element.

Since Audio-Technica already has proprietary technology that provides extended low-end frequency response from even a very small-diaphragm, unidirectional microphone, such as the AT898 subminiature lavalier mic, it was not necessary to rely on a large-diaphragm design from a frequency response point of view. However, aside from specifications, we also understood that capturing the artistic presence and energy of music was a key component to achieving “purity of sound.” To accomplish that, a large-diaphragm design would be needed. Additionally, by increasing the diaphragm size we could reduce the self-noise and thereby increase the signal-to-noise ratio – a very important performance issue.

At the same time, we needed to consider the typical drawbacks of using a large-diaphragm design: limited high-frequency response, a potentially more rigid and less reactive diaphragm, temperature stability issues, and increased space between the back plate and the diaphragm that can impact sensitivity and otherwise diminish performance.

To address these issues, Audio-Technica engineers developed a rectangular element. Since a rectangular element has a short side and a long side, unlike conventional circular elements, it provides the benefits of both small- and large-diameter circular elements.

Since the width of the element is in line with a small-diameter circular element, the frequency response can be extended smoothly up to 20 kHz. And since the height of the element provides an effective diaphragm area that is similar – or even larger – than a large-diameter circular element, the noise floor is reduced and the signal-to-noise ratio is increased.

For the 50 Series microphones we developed rectangular elements in the following two sizes:

1. 12.0 mm x 21.2 mm (254.4 mm²)
2. 12.0 mm x 34.6 mm (415.2 mm²)

Each diaphragm used for these rectangular elements has been carefully engineered to improve transient response and increase response bandwidth. Each is 2 microns thick, vapor-deposited gold, and aged to unify and stabilize the diaphragm tensions so that the optimum characteristics remain constant over years of use. Each employs Audio-Technica’s

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patented double-wave honeycomb surface to increase effective diaphragm area and stability. In addition, each benefits from Audio-Technica’s proprietary production process controls and equipment. These process control advances are not limited to the diaphragm assemblies, but also benefit many other important assemblies in the element, such as the back plate, back cavities, acoustic resistance materials and more.

To maximize the performance of the 50 Series microphones, we chose the fixed-charge element design based on Audio-Technica’s long-proven proprietary technology. The back plate of each diaphragm holds a fixed charge and has been aged to provide energy stabilization and exacting charge linearity. This also benefits performance through a reduction in both frequency response peaks and diaphragm breakup distortion.

Four-Part Rectangular Large-Diaphragm Element

We determined the size of the first rectangular element (item number 1 above) based on our aim of combining four of these elements together to produce one four-part rectangular large-diaphragm element. This four-part rectangular element was designed for use in the AT5040 and AT5047 large-diaphragm, side-address microphones.

In these microphones, the four rectangular elements function together as a single, high-performance capsule, the largest that Audio-Technica has ever created. The outputs of the four elements are summed in pairs (element 1 with element 2; element 3 with element 4) using proprietary circuitry.

Since each of the four individual elements offers 254.4 mm² of effective diaphragm area, the total effective diaphragm area of the four elements combined is 1,017.6 mm². This is quite large; if we wanted to achieve this effective diaphragm area by using a conventional circular diaphragm design, the diameter would need to be 36 mm.

This unique four-part element design offers spectacular advantages. An increase in diaphragm surface area allows for a natural increase in energy transfer, resulting in more realism, greater depth and increased presence – all related to “purity of sound.” It also offers an improved and smoother off-axis response than was possible when using a conventional circular element and an extended high-end frequency response of up to 20 kHz. Using four elements in a single capsule allows us to achieve these benefits – along with an extremely low noise floor – without increasing the weight, decreasing transient response or encountering other drawbacks that typically restrict diaphragm size.

Single-Diaphragm Element

The single-diaphragm element (item number 2 above) was designed for the AT5045 studio instrument condenser microphone. Unlike the other two 50 Series microphones, the AT5045 was specifically designed as an instrument microphone, and thus given a stick-type, side-address architecture. The outer diameter of the microphone body’s element housing is 22 mm, which is less than half that of the AT5040 and AT5047. For this reason, the AT5045 employs a single-diaphragm design. The rectangular-shaped element has the same width as one of the four elements in the AT5040

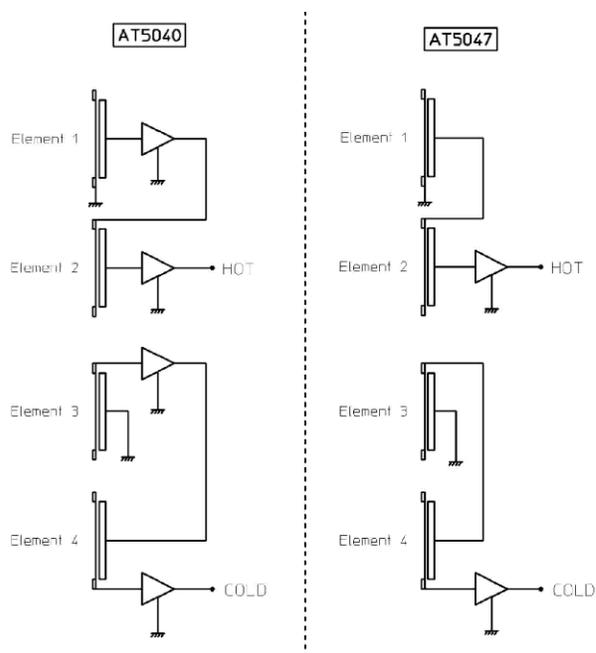
and AT5047, but its length extends to 34.6 mm, maximizing the effective diaphragm area. With this design, and despite its stick-type body, the AT5045 has an element with a larger effective diaphragm area (415.2 mm²) than any of our 40 Series large-diaphragm side-address microphones.

Circuit Design

To ensure optimum performance, the circuitry for the 50 Series elements has been honed to a select number of discrete electronic components, each carefully chosen for its effect on the overall sound quality.

• AT5040 and AT5047 Element Buffer Section

To utilize the four-part rectangular element as one capsule it is essential to have a combiner circuit. But since we wanted to achieve greater max SPL with the AT5047, the unique method of combining the outputs of the four independent elements is different in the two models.



To provide best results in sound quality for each product, the patented AT5040 circuit uses a buffer amplifier for the first and third elements and through these feeds signals to the summing elements of the second and fourth elements. The patent-pending AT5047 circuit, on the other hand, directly sums the elements instead of using a buffer amplifier. By means of these proprietary summing methods we have been able to quadruple the microphones’ sensitivity, while maintaining exceptionally low self-noise. This is why, for example, the AT5040 can provide a high sensitivity of -25 dB SPL and a signal-to-noise-ratio of 89 dB, while keeping the maximum input sound level at 142 dB SPL.

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• AT5045 Element Buffer Section

The element buffer section of the AT5045 utilizes a circuit similar to that used in the AT5040. Since the AT5045 has a single-diaphragm design, the circuit is much simpler, with no signal combiner section. High maximum SPL handling capability is essential for this instrument microphone, so we minimized the current consumption to both increase the buffer circuit drive voltage and lower the noise.

• AT5040 output stage

Since the AT5040 is specifically designed to get “purity of sound” reproduction from vocals, we utilized a transformerless output stage design so as not to colorize the sound in any way. Since phantom-powered condenser microphones generally obtain power to drive the circuit through two 6.8 k ohm resistors, transformerless designs tend to use an emitter follower circuit that utilizes both 6.8 k ohm phantom resistors as load and obtains power from the collector. This is how the AT5040 operates, using an emitter follower circuit for the output stage to produce audio signals on the phantom resistors, while obtaining power through the resistors at the same time.

• AT5045 and AT5047 output stage

The AT5045 is mainly designed for use with instruments, while the AT5047 is designed to be highly versatile. In order to get the best performance from both of these microphones, we decided to use a transformer in the output stage. By using a transformer, we obtain DC power for the microphone circuit through two 6.8 k ohm phantom resistors that are independent from the audio output. This means that the transformer output stage tends to provide better load resistor drive capability than the transformerless output stage design. This is advantageous when capturing the high-SPL signals that are more commonly associated with instrument pickup than with studio vocal recording.

• Fixed-charge element

As described in the Microphone Element section, to maximize the performance of the 50 Series elements, we decided against a true condenser design and instead went with a fixed-charge element design. By using a fixed-charge element, there is no need to add a dedicated DC-to-DC converter. Thus, the fixed-charge design not only saves the current, but eliminates the negative effect of the oscillator noise produced by the converter.

• Audio circuit limited to the essentials

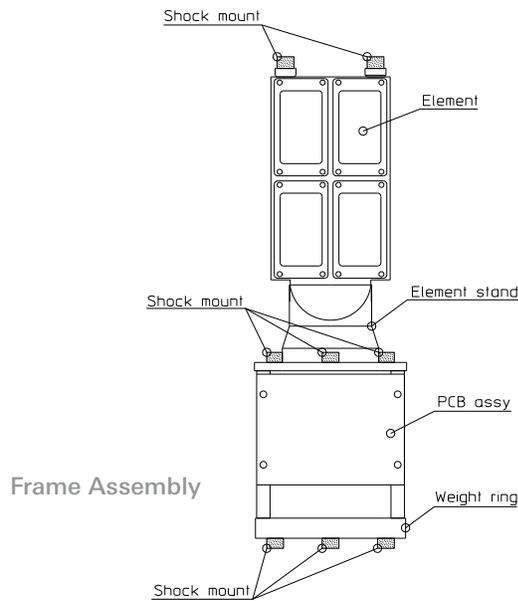
To maintain “purity of sound,” our engineers eliminated any unnecessary circuitry in the audio signal line, including switches, gain pads, and other nonessential components.

Precise Body Construction

The internal structures of the 50 Series microphones are designed to float free from the outer microphone body within an advanced internal shock mount that effectively decouples the microphone element from any vibrations applied to the microphone body.

• AT5040 and AT5047

The capsule assembly and circuitry float independently of each other and of the microphone body.



AT5040



AT5047

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- **AT5045**

Since there is limited space within the stick-shaped AT5045, the capsule assembly and circuitry are mounted as a single block within the internal shock mounting, which floats free of the microphone body.



To further isolate the microphones from vibration, the AT5040 and the AT5047 are supplied with the AT8480 shock mount and the AT5045 is supplied with the AT8481 stand clamp (optional AT8482 shock mount available separately). The proprietary designs of the AT8480, AT8481 and AT8482 were engineered both to isolate the microphone element and to eliminate any unwanted resonance or other audio aberrations that could be transmitted to the element. The AT8480 and AT8481 also feature a unique locking mechanism to hold the microphone securely in place.

The solid aluminum bottom body shell of each microphone is threaded onto the top double-layered mesh grill assembly. To further reduce the potential for unwanted resonance, the two layers of mesh have been fused together. By rigidly connecting and unifying these parts of the microphone body, we were able to eliminate the need for any components related to RFI countermeasures.