



# Acoustic Interface Design Guide—2010

MEMS MICROPHONES 

SPECIALTY MICROPHONES 

BOOMS AND SENSORS 

ACCELEROMETERS & ACOUSTIC DAMPER SCREENS 

SPECIALTY SPEAKERS 

CUSTOM ASSEMBLIES 

ACOUSTIC SOFTWARE 

MICROPHONE AND SPEAKER BASICS 

# Discover your next acoustic interface solution.



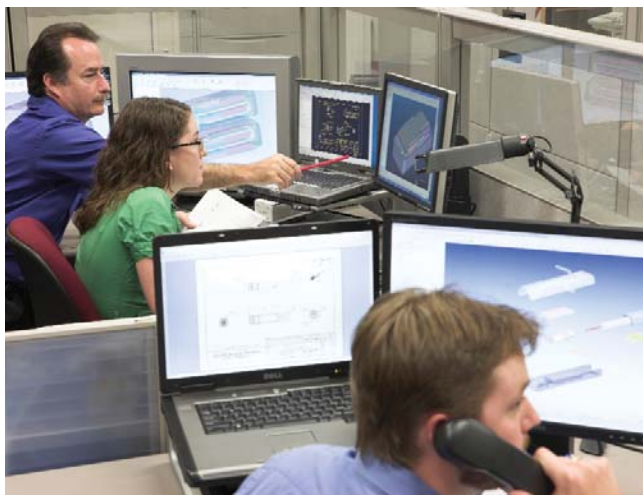
Knowles Acoustics offers you a full spectrum of MEMS microphones, specialty microphones, balanced armature speakers, custom assemblies, and sound conditioning software. This application guide will help you select the right acoustic interface solution.

OVER **60** YEARS  
acoustic innovation

*Knowles reserves the right to change designs and specifications without prior notice. Should a safety concern arise regarding this product, please contact us immediately for technical consultation. Knowles cannot assume responsibility for any problems arising out of the use of this product. This information does not convey any license by any implication under any patents or other right.*

# We can help you every step of the way.

It all starts with your application. Or it starts with an idea you may have. For support from concept to design to sub-assembly, or any step along the way, just call us. Or visit us at [www.knowles.com](http://www.knowles.com)



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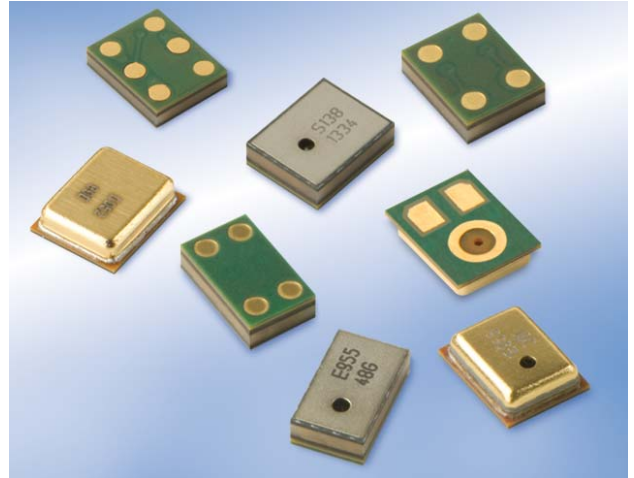
# MICROPHONES — MEMS

## SiSonic™ MEMS Microphones

Built on our CMOS/MEMS technology platform, the SiSonic™ silicon-based MEMS microphone series is a step ahead of the competition with product shipments exceeding 1 billion units to date. The proven and evolving design series continues to support high-performance, high-density innovation in such applications as cell phones, smart phones, laptop computers, sensors, digital still cameras, portable music players, and other portable electronic devices.

Design variables include ever-smaller sizes, lower profiles and mounting options, increased output capacities, and new digital audio options that eliminate analog noise. For manufacturers, surface mount designs eliminate off-line subassembly production costs. Customized designs are supplied on tape-and-reel and can be run through standard automatic pick-n-place equipment during in-line surface mount manufacturing.

The microphones can also be integrated with our patented IntelliSonic™ software and special porting designs to provide a precisely customized sound.



- New MaxRF models eliminate GSM/TDMA burst noise and provide wide-band RF noise suppression
- UltraMini footprint - less than 11.5mm<sup>2</sup> (SPU Series)
- Slim UltraMini footprint - less than 8.5mm<sup>2</sup> (SPQ Series)
- Digital mics eliminate analog noise
- Integrated designs with differential or switchable gain
- Zero Height Mic™ for thinnest ever designs

## Part Numbering

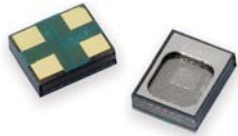
### SPM0404HE5H-PB-6



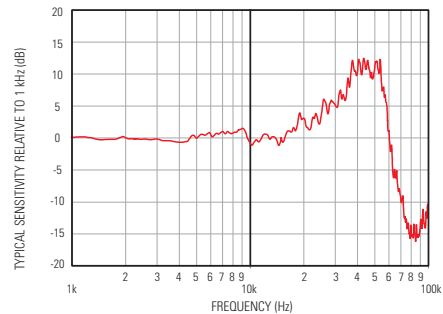
| 1                                  | 2                     | 3              | 4           | 5              | 6            | 7                | 8                |
|------------------------------------|-----------------------|----------------|-------------|----------------|--------------|------------------|------------------|
| Product Description                | Series                | Port Hole Type | RF Filter   | Supply Voltage | Halogen Free | Version          | Packaging QTY    |
| SPU: Ultra-Mini (3.76 x 2.95)      | 0404: Unity Gain      | H: Top Port    | D: Standard | 3: 1.5-5.5V    |              | Knowles Internal | Product Specific |
| SPU: Ultra-Mini (3.76 x 3.00)      | 0405: Digital         | L: Bottom Port | E: Enhanced | 4: 1.6-3.6V    |              | (Reference Only) | (Reference Only) |
| SPM: Mini (4.72 x 3.76)            | 0406: Differential    |                | R: MAX-RF   | 5: 1.5-3.6V    |              |                  |                  |
| SPQ: Slim Ultra-Mini (3.76 x 2.24) | 0407: Switchable Gain |                |             |                |              |                  |                  |
| SPK: (4.00 x 3.00)                 | 0408: Amplified       |                |             |                |              |                  |                  |
|                                    | 0409: Unity Gain      |                |             |                |              |                  |                  |
|                                    | 0410: Unity Gain      |                |             |                |              |                  |                  |
|                                    | 0413: Digital         |                |             |                |              |                  |                  |
|                                    | 0414: Amplified       |                |             |                |              |                  |                  |

## Ultrasonic Acoustic Sensor

Derived from our industry-leading MEMS silicon surface mount microphone technology, our new ultrasonic sensor designs function on a high frequency band. Sensor designs are possible across a wide spectrum of applications requiring highly miniaturized solutions for sensing and actuation/signaling.

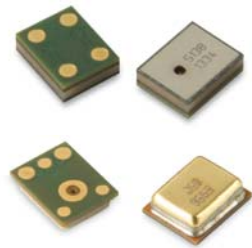


- High frequency functionality
- Wide range of applications
- Micro-sized sensing and actuation

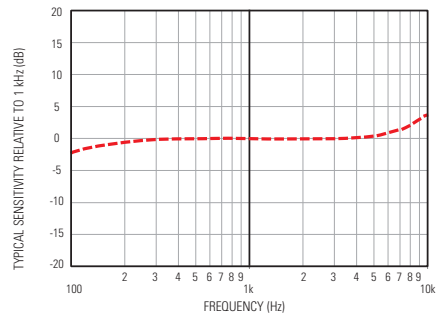


| Model      | Description | Directivity | Supply Voltage (min-max) | Sensitivity @1kHz (dB re1V/1Pa) | Output Impedance (Ohms) | Maximum Current Drain (mA) |
|------------|-------------|-------------|--------------------------|---------------------------------|-------------------------|----------------------------|
| SPM0404UD5 | Unity Gain  | Omni        | 1.5 to 3.6v              | -42.0                           | <100                    | <0.25                      |

## Ultra Mini Package

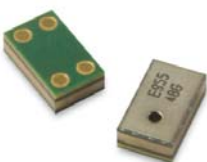


- New Ultra Mini with footprint of 11mm<sup>2</sup>
- Flexible designs available with/without RF filtering and built in amplifier
- Ideal for miniature consumer electronics

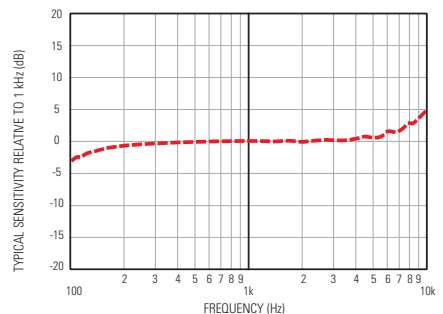


| Model       | Description | Directivity | Supply Voltage (min-max) | RF Immunity | Sensitivity @1kHz (dB re1V/1Pa) | Output Impedance (Ohms) | Maximum Current Drain (mA) |
|-------------|-------------|-------------|--------------------------|-------------|---------------------------------|-------------------------|----------------------------|
| SPUL409HE5H | Unity Gain  | Omni        | 1.5 to 3.6v              | Enhanced    | -42.0                           | <300                    | <0.25                      |
| SPU0409HD5H | Unity Gain  | Omni        | 1.5 to 3.6v              | Standard    | -42.0                           | <100                    | <0.25                      |
| SPU0410HR5H | Unity Gain  | Omni        | 1.5 to 3.6v              | Max-RF      | -42.0                           | <400                    | <0.25                      |
| SPU0414HR5H | Amplified   | Omni        | 1.5 to 3.6v              | Max-RF      | -22.0                           | <400                    | <0.35                      |

## Slim-Ultra Mini Package



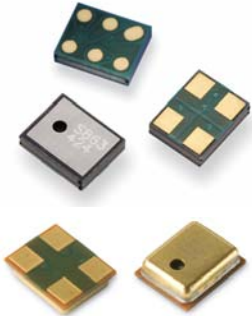
- 24% reduction of footprint (8.4mm<sup>2</sup>) from the Ultra-Mini Package
- Designs available with/without RF Filtering
- Ideal for miniature consumer electronics



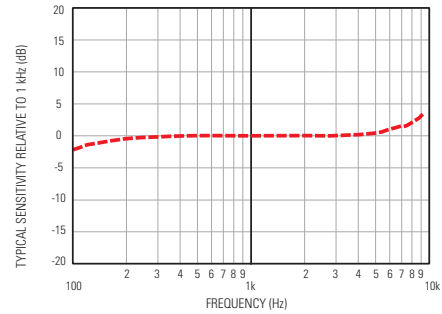
| Model       | Description | Directivity | Supply Voltage (min-max) | RF Immunity | Sensitivity @1kHz (dB re1V/1Pa) | Output Impedance (Ohms) | Maximum Current Drain (mA) |
|-------------|-------------|-------------|--------------------------|-------------|---------------------------------|-------------------------|----------------------------|
| SPQ0410HE5H | Unity Gain  | Omni        | 1.5 to 3.6v              | Enhanced    | -42.0                           | <400                    | <0.25                      |

# MICROPHONES — MEMS

## Thin Mini Package

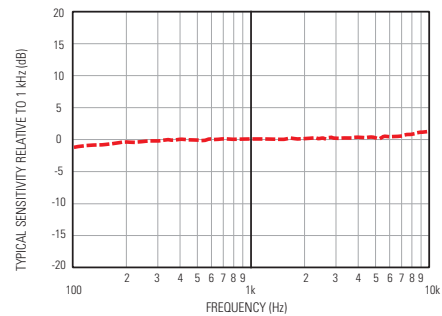
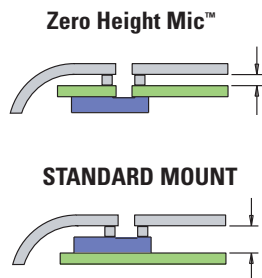
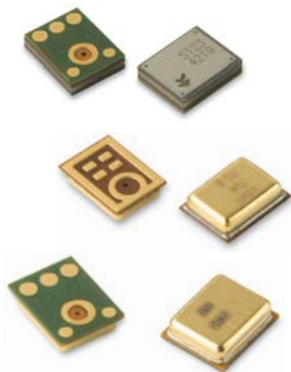


- Thin Mini SiSonic with a footprint less than 18mm<sup>2</sup> reduces manufacturing costs and brings greater design flexibility
- Rugged, solid-state design process for stable acoustic performance under extreme conditions such as temperature, shock and vibration
- Digital - Pulse Density Modulation (PDM) device available, which has an integrated sleep mode and is compatible with stereo input applications



| Model       | Description     | Directivity | Supply Voltage (min-max) | RF Immunity      | Sensitivity @1kHz (dB re1V/1Pa) | Output Impedance (Ohms) | Maximum Current Drain (mA) |
|-------------|-----------------|-------------|--------------------------|------------------|---------------------------------|-------------------------|----------------------------|
| SPM0404HD5H | Unity Gain      | Omni        | 1.5 to 3.6v              | Standard         | -42.0                           | <100                    | <0.25                      |
| SPM0406HE3H | Differential    | Omni        | 1.5 to 5.5v              | Enhanced         | -22.0                           | <500                    | <0.50                      |
| SPM0407HE3H | Switchable Gain | Omni        | 1.5 to 5.5v              | Enhanced         | -22.0                           | <300                    | <0.37                      |
| SPM0408HD5H | Amplified       | Omni        | 1.5 to 3.6v              | Standard         | -22.0                           | <100                    | <0.35                      |
| SPM0404HE5H | Unity Gain      | Omni        | 1.5 to 3.6v              | Enhanced         | -42.0                           | <200                    | <0.25                      |
| SPM0405HD4H | Digital         | Omni        | 1.6 to 3.6v              | Digital Standard | -26.0 (dBFS/1Pa)                | 100pf<br>Maximum Load   | <0.60                      |
| SPM0408HE5H | Amplified       | Omni        | 1.5 to 3.6v              | Enhanced         | -22.0                           | <200                    | <0.35                      |
| SPM0410HR5H | Unity Gain      | Omni        | 1.5 to 3.6v              | Max-RF           | -42.0                           | <400                    | <0.25                      |

## Zero Height Mic™ SiSonic



- Zero Height Mic™ SiSonic shrinks product thickness by up to 30%
- Minimizes distance between PCB and mobile device housing
- Ideal for microphone placement on reverse side of PCB, while maintaining acoustic port on top side of mobile device, for clamshell phone designs
- Enables the thinnest, highest density product designs

| Model       | Description | Directivity | Supply Voltage (min-max) | RF Immunity      | Sensitivity @1kHz (dB re1V/1Pa) | Output Impedance (Ohms) | Maximum Current Drain (mA) |
|-------------|-------------|-------------|--------------------------|------------------|---------------------------------|-------------------------|----------------------------|
| SPM0404LE5H | Unity Gain  | Omni        | 1.5 to 3.6v              | Enhanced         | -38.0                           | <200                    | <0.25                      |
| SPM0408LE5H | Amplified   | Omni        | 1.5 to 3.6v              | Enhanced         | -18.0                           | <200                    | <0.35                      |
| SPM0410LR5H | Unity Gain  | Omni        | 1.5 to 3.6v              | Max-RF           | -38.0                           | <400                    | <0.25                      |
| SPU0409LE5H | Unity Gain  | Omni        | 1.5 to 3.6v              | Enhanced         | -38.0                           | <200                    | <0.25                      |
| SPU0410LR5H | Unity Gain  | Omni        | 1.5 to 3.6v              | Max-RF           | -38.0                           | <400                    | <0.25                      |
| SPK0413LM4H | Digital     | Omni        | 1.6 to 3.6v              | Digital Enhanced | -26.0 (dBFS/1Pa)                | 100pf<br>Maximum Load   | <0.65                      |

# SPECIALTY TRANSDUCERS — Microphones

## Specialty Transducer Microphones

The Specialty Transducer (ST) product line consists of miniature microphones, speakers, and assemblies. Hundreds of design possibilities can be applied to your product challenge with our high-performance microphone designs. Ideal for new product ideas that require premium audio and very small form factors, solutions include noise canceling, omni-directional and unidirectional performance. Other variables include size, shape, amplification, sensitivity, low noise, and resistance to vibration and mechanical shock.

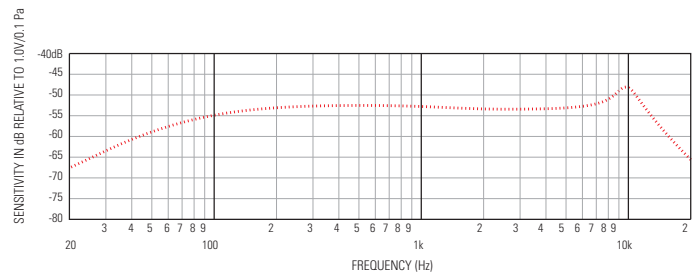
ST components and assemblies are unique in fit, form and function. Our products are designed into high value applications in markets such as the following:

- Communications – headsets, handsets, earpieces, telephony, voice recognition, emergency services, military, surveillance
- Pro audio – in-ear speakers, lapel microphones, boom microphones
- Medical and more – sensors, audiometers, medical implants



## GA SERIES – Microphone Omni-Directional 2.00 x 2.00 x 4.00 (mm)

The GA Series Microphone is a brand new microphone design with unique size and shape. Its elongated 2mm x 2mm x 4mm dimensions are ideal for directional applications, allowing you ultimate flexibility in terminal pad area placement. And the GA is using the new '38' circuit providing excellent sensitivity and noise performance for package size. The GA targets space efficiency in BTE and ITE designs; BTE: End-to-end configuration provides 8mm spacing for directionality while ITE: 20% smaller cross sectional area than FG Series.



- Compact size providing superior fit rates (2mm x 2mm x 4mm)
- Excellent sensitivity and noise performance for package
- Integral RFI suppression
- Exceptionally low vibration sensitivity
- Multiple acoustic port placement versions

| Model          | Sensitivity @ 1kHz (dB re1V/0.1Pa) | DC Supply (Vdc)  | Max. Amplifier Current Drain (uA) | Max. "A" Weighted Noise (1 kHz Equivalent SPL) | Nominal Output Impedance (Ohms) | Comments   |
|----------------|------------------------------------|------------------|-----------------------------------|--|---------------------------------|--|
| GA38-30774-000 | -53.0±3                            | 1.3 nom. 1.6 max | 25                                | 24.0 dB  | 4400                            | Tubeless, Port on Bottom, Terminal Pads on Cover       |
| GA38-30775-000 | -53.0±3                            | 1.3 nom. 1.6 max | 25                                | 25.0 dB  | 4400                            | Tubeless, Port on End, Terminal Pads on End            |
| GA38-30776-000 | -53.0±3                            | 1.3 nom. 1.6 max | 25                                | 25.0 dB  | 4400                            | Tube Version (0.8mm x 0.74mm ID), Terminal Pads on End |

# SPECIALTY TRANSDUCERS — Microphones

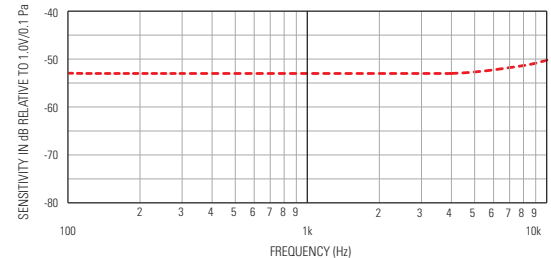
## FG/DFG SERIES – Microphone

### Omni-Directional (FG), Directional (DFG) 2.56 DIA x 2.56 (mm)

The FG Series microphone is the world's smallest electret condenser microphone. Its cylindrical shape and compact size facilitate compact designs. The FG can also be used in directional applications as a matched omni-directional pair.



- Smallest microphone option
- High resistance to mechanical shock
- Exceptionally low vibration sensitivity
- Various responses available
- Integral RFI suppression



| Model         | Sensitivity @ 1kHz (dB re1V/0.1Pa) | DC Supply (Vdc)  | Max. Amplifier Current Drain (uA) | "A" Weighted Noise * 1kHz Equivalent SPL ** re 1Vrms | Nominal Output Impedance (Ohms) | Comments                                     |
|---------------|------------------------------------|------------------|-----------------------------------|--|---------------------------------|--|
| FG-23329-D65  | -53.0±3                            | 1.3 nom. 3.0 max | 50                                | 30.0 dB*   | 4400                            | RFI Improved Version                         |
| FG-23329-P07  | -53.0±3                            | 1.3 nom. 3.0 max | 50                                | 30.0 dB*   | 4400                            | 3-Wire, 1015mm Shielded Cable                |
| FG-23629-P16  | -53.0±3                            | 1.3 nom. 3.0 max | 50                                | 28.0 dB*   | 4400                            | 3-Wire, 25.4mm Litz Wires                    |
| FG-23629-D65  | -53.0±3                            | 1.3 nom. 3.0 max | 50                                | 28.0 dB*   | 4400                            | RFI Improved Version                         |
| FG-23652-D65  | -53.0±3                            | 1.3 nom. 3.0 max | 50                                | 28.0 dB*   | 4400                            | RFI Improved Version                         |
| FG-23652-P16  | -53.0±3                            | 1.3 nom. 3.0 max | 50                                | 28.0 dB*   | 4400                            | 3-Wire, 25.4mm Litz Wires                    |
| FG-23742-D36  | -63.0±3                            | 1.3 nom. 3.0 max | 50                                | 36.0 dB*   | 4400                            | 3-Wire, 25.4mm Litz Wires                    |
| FG-26163-D65  | -58.0±3                            | 1.3 nom. 3.0 max | 50                                | -93.0 dB**   | 4400                            | RFI Improved Version<br>6dB/Octave Ski-Slope |
| DFG-30344-000 | -67.0±3                            | 1.3 nom. 3.0 max | 50                                | -93.0 dB**   | 700                             | Directional, Super Cardioid                  |
| DFG-30852-000 | -69.0±3                            | 1.3 nom. 3.0 max | 50                                | -93.0 dB**   | 1700                            | Directional, Cardioid                        |
| DFG-30851-000 | -73.0±3                            | 1.3 nom. 3.0 max | 50                                | -93.0 dB**   | 1700                            | Directional, Noise Canceling                 |

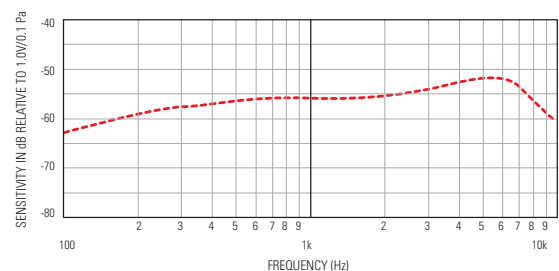
## EM SERIES – Microphone

### Omni-Directional 3.63 x 3.63 x 2.28 (mm)

The EM is a popular, alternative omni-directional microphone. The EM can also be used in directional applications as a matched omni-directional pair.



- High resistance to mechanical shock
- Improved RFI and EMI
- Undamped, screen damped, and internally damped responses
- Numerous port locations
- Wide range of frequency responses



| Model        | Sensitivity @ 1kHz (dB re1V/0.1Pa) | DC Supply (Vdc)  | Max. Amplifier Current Drain (uA) | "A" Weighted Noise * 1kHz Equivalent SPL ** re 1Vrms | Nominal Output Impedance (Ohms) | Comments                                      |
|--------------|------------------------------------|------------------|-----------------------------------|--|---------------------------------|---|
| EM-23046-P16 | -56.0±3                            | 1.3 nom. 3.0 max | 50                                | 31.0 dB*   | 4400                            | 3-Wire, 25.4mm Litz Wire<br>Standard Response |
| EM-23069-000 | -56.0±3                            | 1.3 nom. 1.6 max | 50                                | 33.0 dB*   | 4400                            | Tubeless<br>Standard Response                 |
| EM-30081-D65 | -68.0±3                            | 1.3 nom. 3.0 max | 50                                | -98.0 dB**   | 4400                            | 12dB/Octave Ski-Slope                         |



# SPECIALTY TRANSDUCERS — Microphones

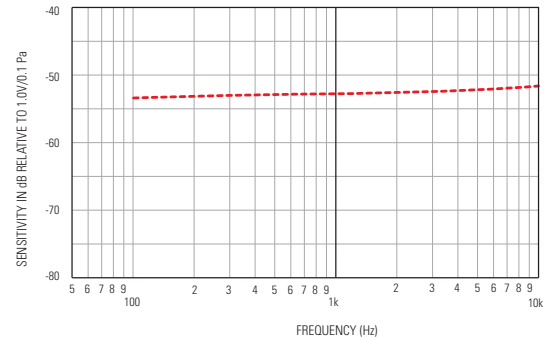
## EK/EL SERIES – Microphone

### Omni-Directional (EK), Unidirectional (EL) 4.00 x 5.59 x 2.28 (mm)

EK omnidirectional microphones provide a unique combination of size, performance and value. Its high electroacoustic sensitivity and low noise make this microphone an excellent choice for applications where space allows. These popular microphones are available in many model varieties.



- High resistance to mechanical shock
- Available with RFI suppression
- Various port locations available
- Wide range of frequency responses
- High S/N performance



| Model        | Sensitivity @ 1kHz (dB re1V/0.1Pa) | DC Supply (Vdc) | Max. Amplifier Current Drain (uA) | "A" Weighted Noise * 1kHz Equivalent SPL ** re 1Vrms | Nominal Output Impedance (Ohms) | Comments                                     |
|--------------|------------------------------------|-----------------|-----------------------------------|--|---------------------------------|--|
| EK-23024-C36 | -53.0±2                            | 1.3 nom. 10 max | 50                                | 26.0 dB*   | 4400                            | RFI Improved Version Standard Response       |
| EK-23024-P07 | -53.0±2                            | 1.3 nom. 10 max | 50                                | 26.0 dB*   | 4400                            | 3-Wire, 1 m Shielded Cable Standard Response |
| EK-23027-C36 | -53.0±2                            | 1.3 nom. 10 max | 50                                | 26.0 dB*   | 4400                            | RFI Improved Version Standard Response       |
| EK-23028-C36 | -57.0±3                            | 1.3 nom. 10 max | 50                                | -100.0 dB**  | 4400                            | RFI Improved Version 6dB/Octave Ski-Slope    |
| EK-23033-C36 | -53.0±2                            | 1.3 nom. 10 max | 50                                | 26.0 dB*   | 4400                            | RFI Improved Version Broadband Response      |
| EK-23132-000 | -53.0±2                            | 1.3 nom. 10 max | 50                                | 26.0 dB*   | 4400                            | Broadband Response                           |
| EK-23133-C36 | -53.0±2                            | 1.3 nom. 10 max | 50                                | 26.0 dB*   | 4400                            | RFI Improved Version Broadband Response      |
| EK-23142-C37 | -53.0±2                            | 1.3 nom. 10 max | 50                                | 26.0 dB*   | 4400                            | RFI Improved Version Broadband Response      |
| EL-23078-000 | -53.0±2                            | 1.3 nom. 10 max | 50                                | -100.0 dB**  | 4400                            | Dual Port Uni-Directional                    |

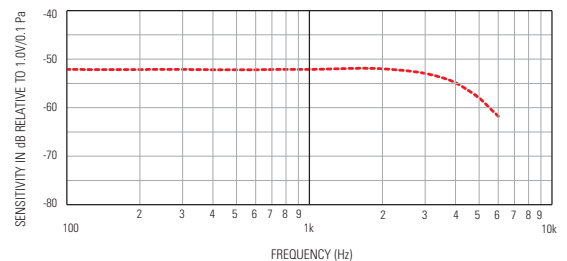
## NR SERIES – Microphone

### Noise Canceling 4.00 x 5.59 x 2.28 (mm)

The NR Series close talking microphones deliver state-of-the-art noise canceling performance. NR microphones are used as headset microphones in the most demanding communication and speech recognition environments. The NR Series microphones are available in boom microphone packages. (See the Specialty Transducers - Booms & Sensors section for details.)



- Integral FET amplifier
- Diaphragm responds to pressure differential giving high rejection of background noise
- Withstands severe environmental conditions
- Low vibration sensitivity
- High electroacoustical sensitivity
- Superior noise canceling performance
- Lead attachment available



| Model        | Sensitivity @ 1kHz (dB re1V/0.1Pa) | DC Supply (Vdc) | Max. Amplifier Current Drain (uA) | Max. "A" Weighted Noise (dBV) | Nominal Output Impedance (Ohms) | Comments |
|--------------|------------------------------------|-----------------|-----------------------------------|-------------------------------|---------------------------------|----------|
| NR-23158-000 | -49.0±3                            | 1.3 nom. 10 max | 50                                | -100                          | 4400                            | 3-Wire   |
| NR-23159-000 | -65.0±3                            | 1.3 nom. 10 max | 200                               | -100                          | 2500                            | 2-Wire   |
| NR-23160-000 | -52.0±3                            | 1.3 nom. 10 max | 200                               | -100                          | 2500                            | 2-Wire   |
| NR-25994-000 | -49.0±3                            | 1.3 nom. 10 max | 50                                | -100                          | 4400                            | 3-Wire   |
| NR-25994-D63 | -55.0±4                            | 1.3 nom. 10 max | 300                               | -100                          | 2000                            | 2-Wire   |
| NR-30610-D63 | -59.0±3                            | 3.0 nom. 10 max | 550                               | -100                          | 2000                            | 2-Wire   |

# SPECIALTY TRANSDUCERS — Microphones

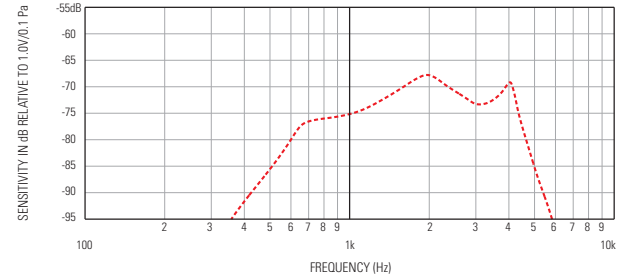
## BJ SERIES – Microphone

### Omni-Directional, Noise Canceling 7.87 x 5.59 x 4.01 (mm)

Knowles' Magnetic Microphones (BJ Series) are based on balanced armature technology and are self-shielded against external magnetic fields. The microphones offer high efficiency, stability, and reliability and are small in size. The diaphragm of the BJ Series responds to pressure differential, giving high rejection of background noise. Both face and edge ports are offered. In addition, there is a short distance between front and back ports resulting in improved noise rejection up to higher frequencies.



- *Balanced armature technology*
- *High efficiency, stability and reliability*
- *Self-shielded against external magnetic fields*
- *Face and edge ports*
- *Diaphragm responds to pressure differential giving high rejection of background noise*
- *Short distance between front and back ports resulting in improved noise rejection up to higher frequencies*



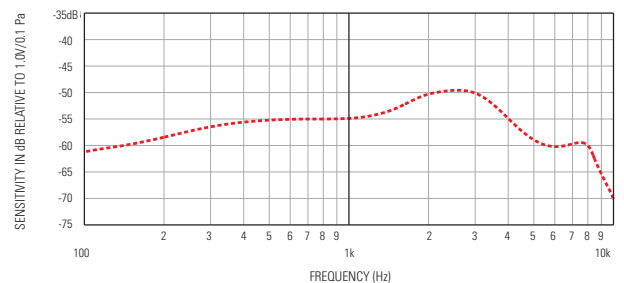
| Model        | Directivity      | Port Location | Nominal Impedance at 1kHz (Ohms) | Nominal DC Resistance at 20° C (Ohms) |
|--------------|------------------|---------------|----------------------------------|---------------------------------------|
| BJ-21590-000 | Omni-Directional | OJn           | 3900                             | 900                                   |
| BJ-28411-000 | Noise Canceling  | Dual          | 300                              | 75.5                                  |

## BL SERIES – Omni-Directional Microphone

Knowles' Piezo Ceramic Microphones (BL Series) are rugged, stable and versatile. BL microphones are available in three different package sizes: standard, thin or 0.5" cylindrical shell and cable assembly. Both communication and broadband frequency response versions are offered. In addition, BL microphones have high vibration sensitivity and may be used as accelerometers.



- *High sensitivity*
- *Wide frequency range*
- *Integral FET amplifier*
- *High resistance to mechanical shock*
- *Various responses*
- *Two case sizes available*



| Model        | Dimensions (mm)    | Sensitivity @ 1kHz (dB re1V/0.1Pa) | DC Supply (Vdc) | Max. Amplifier Current Drain (uA) | "A" Weighted Noise | Nominal Output Impedance (Ohms) | Comments  |
|--------------|--------------------|------------------------------------|-----------------|-----------------------------------|--------------------|---------------------------------|---|
| BL-21671-000 | 7.87 x 5.54 x 4.06 | -54.0±3                            | 1.3             | 50                                | 32.0 dB            | 13000                           | Standard Response                                 |
| BL-21671-140 | 7.87 x 5.84 x 4.06 | -54.0±4                            | 1.3             | 50                                | 32.0 dB            | 13000                           | Faster Overpressure Recovery<br>Standard Response |
| BL-21785-000 | 7.87 x 5.54 x 2.24 | -69.0±3                            | 3               | 160                               | 34.0 dB            | 4000                            | Broadband Response                                |
| BL-21994-000 | 25.5               | -69.0±3                            | 3               | 160                               | 34.0 dB            | 4000                            | 965mm Shielded Cable<br>Broadband Response        |
| BL-23497-000 | 25.5               | -69.0±3                            | 3               | 160                               | 34.0 dB            | 4000                            | 34.3mm Leads<br>Broadband Response                |
| BL-27046-000 | 7.87 x 5.54 x 2.24 | -69.0±3                            | 1.3             | 160                               | 34.0 dB            | 4000                            | Broadband Response                                |

# SPECIALTY TRANSDUCERS — Microphones

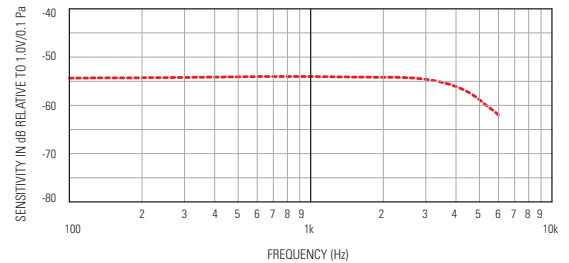
## WP SERIES – Waterproof Microphone

### Omni-Directional, Noise Canceling 3.99 x 5.56 x 2.21 (mm)

The WP Series' form factor is a very small size with low vibration sensitivity. The excellent noise canceling performance is useful for sensors and instrumentation. The WP Series are available in boom microphone packages. (See the FB Series and PNR/PWP Series for details.)



- Waterproofed to submersion in 1m water
- Close-talking (noise-canceling)
- Corrosion resistant
- Withstands explosive decompression
- Excellent environmental performance
- High resistance to mechanical shock



| Model        | Sensitivity @ 1kHz (dB re1V/0.1Pa) | Directivity      | DC Supply (Vdc) | Max. Amplifier Current Drain (uA) | "A" Weighted Noise * 1kHz Equivalent SPL ** re 1Vrms | Nominal Output Impedance (Ohms) | Comments                                 |
|--------------|------------------------------------|------------------|-----------------|-----------------------------------|--|---------------------------------|--|
| WP-23501-000 | -54.0±3                            | Noise Canceling  | 1.3 nom. 10 max | 300                               | -100 dB**  | 2500                            | 2-Wire                                   |
| WP-23502-000 | -52.0±3                            | Omni-Directional | 1.3 nom. 10 max | 50                                | 26.0 dB*   | 4400                            | 3-Wire                                   |
| WP-23502-P07 | -52.0±3                            | Omni-Directional | 1.3 nom. 10 max | 50                                | 26.0 dB*   | 4400                            | 3-Wire, w/ 1m Shielded Cable             |
| WP-23502-P16 | -52.0±3                            | Omni-Directional | 1.3 nom. 10 max | 50                                | 26.0 dB*   | 4400                            | 3-Wire, w/ 25.4mm Litz Wires             |
| WP-23849-C36 | -52.0±3                            | Omni-Directional | 1.3 nom. 10 max | 50                                | 26.0 dB*   | 4400                            | 3-Wire, RFI Improved + Extended Response |
| WP-25993-D63 | -55.0±4                            | Noise Canceling  | 1.3 nom. 10 max | 300                               | -100 dB**  | 2000                            | 2-Wire                                   |

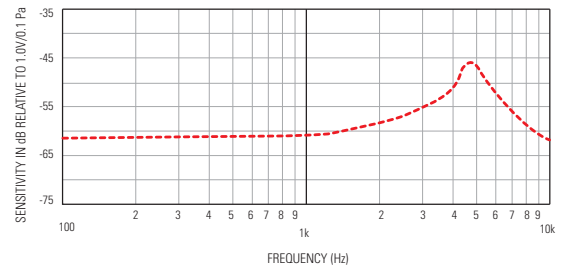
## MR SERIES – Waterproof Microphone

### Omni-Directional

The MR Series Assemblies consist of a microphone element attached to a bellows assembly. They may be panel mounted, attached for boom applications, and are suitable for outdoor use or repeated submersion.



- Highly waterproof – no loss of performance after immersion in 15-20 m water
- Corrosion resistant
- Withstands explosive decompression
- Design proven in rugged environments
- Cable wire attached
- High resistance to mechanical shock
- Acoustically transparent bellows
- Resists effects of mud, sand, and salt encrustation



| Model        | Dimensions (mm)   | Sensitivity @ 1kHz (dB re1V/0.1Pa) | DC Supply (Vdc) | Max. Amplifier Current Drain (uA) | "A" Weighted Noise | Nominal Output Impedance (Ohms) | Comments            |
|--------------|-------------------|------------------------------------|-----------------|-----------------------------------|--------------------|---------------------------------|---------------------|
| MR-23151-000 | 22.12 DIA x 9.3   | -87.0±3                            | N/A             | N/A                               | 30.0 dB            | 300                             | 2-Wire, 193mm Leads |
| MR-23793-000 | 22.12 DIA x 11.43 | -60.0±4                            | 1.3             | 100                               | 31.0 dB            | 2500                            | 3-Wire, 201mm Leads |
| MR-28406-000 | 22.12 DIA x 7.6   | -60.0±3                            | 1.3             | 50                                | 30.0 dB            | 3500                            | 3-Wire, 202mm Leads |

# SPECIALTY TRANSDUCERS — Booms & Sensors

## Booms & Sensors

Knowles' boom microphones are designed for either flexible or rigid configurations and offer such performance options as noise rejection and high-frequency crossover of near and far field responses. Lengths and end terminations are customized to meet your application needs. Marketers of headsets and audio systems often seek Knowles boom designs. Collaboration with commercial, governmental and industrial designers is producing new helmet applications for aircraft, military, first responder and high-noise manufacturing environments.

- Standard and waterproof
- Flexible and rigid styles
- Boom housing available in plastic and metal
- Customized lengths and end terminations



## Part Numbering

**FB-F I -30026-000**



**1**  
**Product Description**  
FB: Flexible Boom

**2**  
**Boom Diameter**  
A: 2.3mm OD Positionable Cable  
B: 2.7mm OD Gooseneck (w/shrink tube)  
D: 4.2mm OD Gooseneck (w/shrink tube)  
E: 5.4mm OD Gooseneck (w/shrink tube)  
F: 5.9mm OD Gooseneck (w/shrink tube)  
H: 5.0mm OD Gooseneck (w/shrink tube)  
M: 1.0mm OD Positionable Tube

**3**  
**Head Series**  
I: BJ Housing  
M: NR/WP Waterproof Housing  
O: Original Housing  
U: FG/DFG Micro Housing  
W: Plastic Housing w/ Sinter Disc

**4**  
**Model #**  
Knowles Internal  
Reference Only

**VWP-F-30109-000**



**1**  
**Product Description**  
V: Value Added

**2**  
**Element Series**  
EK, EA, WP

**3**  
**Housing Series**  
B: Over Molded  
C: Custom Design  
F: Plastic Fixed Housing  
H: ESD Shielded Plastic

**4**  
**Model #**  
Knowles Internal  
Reference Only

# SPECIALTY TRANSDUCERS — Booms & Sensors

## I SERIES



- Designed for military customers who are looking for a noise canceling non-power element in robust platform with waterproofing options from 1m down to 10m (based on IP67 rating)
  - Also available in Omni-Directional
  - Meets MIL-STD-810F standards
- Plastic head design with metal flexible boom
  - Available in 5.9mm down to 4.2mm diameter metal flexible boom
- Military forces, Special Operations, Security and Police and other military communication headsets
  - Mounted and un-mounted ground forces, armor units
- Designed for the BJ series elements

| Model           | *Rating | Microphone Element               | Directivity     | Boom Length Tip-To-Tip (mm) | Exit Wire Length (mm) | Nominal Boom Diameter (mm) | Microphone Configuration |
|-----------------|---------|----------------------------------|-----------------|-----------------------------|-----------------------|----------------------------|--------------------------|
| FB-EI-30026-000 | 1m      | BJ-28471-000<br>(150Ω Impedance) | Noise Canceling | 172                         | 60                    | 5.4                        | 2-Wire                   |
| FB-EI-30426-000 | 1m      | BJ-28486-000<br>(30Ω Impedance)  | Noise Canceling | 172                         | 60                    | 5.4                        | 2-Wire                   |

\*Rating done to IP67 test criteria

## M SERIES



- Designed for military customers who are looking for a noise canceling electret element in robust waterproof housing
  - Available in Omni-Directional
  - Waterproof options from 1m down to 20m (per IP67, IP68 and MIL-STD-810F)
- Plastic head design with metal flexible boom
  - Available in 6.0mm down to 2.7mm diameter metal flexible boom
- Military forces, Special Operations, Security, Fire and Police and other high end communication headsets
  - Over the ear, earcup or helmet designs for mounted and non-mounted ground forces
- Designed for EK, NR and WP series elements

| Model           | *Rating | †Microphone Element | Directivity      | Boom Length Tip-To-Tip (mm) | Exit Wire Length (mm) | Nominal Boom Diameter (mm) | Microphone Configuration |
|-----------------|---------|---------------------|------------------|-----------------------------|-----------------------|----------------------------|--------------------------|
| FB-EM-30342-000 | 1m      | NR-25994-D63        | Noise Canceling  | 167                         | 60                    | 5.4                        | 2-Wire                   |
| FB-EM-30343-000 | 3m      | WP-25993-D63        | Noise Canceling  | 167                         | 60                    | 5.4                        | 2-Wire                   |
| FB-EM-30344-000 | 10m     | NR-25994-D63        | Noise Canceling  | 167                         | 60                    | 5.4                        | 2-Wire                   |
| FB-EM-30345-000 | 20m     | NR-25994-D63        | Noise Canceling  | 167                         | 60                    | 5.4                        | 2-Wire                   |
| FB-EM-30346-000 | 1m      | EK-23132-C36        | Omni-Directional | 167                         | 60                    | 5.4                        | 2-Wire                   |
| FB-EM-30348-000 | 10m     | EK-23132-C36        | Omni-Directional | 167                         | 60                    | 5.4                        | 2-Wire                   |
| FB-EM-30349-000 | 20m     | EK-23132-C36        | Omni-Directional | 167                         | 60                    | 5.4                        | 2-Wire                   |

\*Rating done to IP67 test criteria † WP-Series elements are waterproof

# SPECIALTY TRANSDUCERS — Booms & Sensors

## U SERIES



- Designed for Pro-Audio and performance customers who are looking for the lightest directional microphone in an ultra slim housing
- Available in Uni-Directional design
- Metal head design with metal position-able boom
- New 1.0mm diameter design available in multiple colors (flesh tones, black, tan, brown, etc...)
- News Anchors, Referees, professional presenters, performance artists and other high-end communication headsets
- In-ear ultra light design
- Designed for the DFG, VFG & FG elements series

| Model           | Rating | Microphone Element | Directivity                      | Boom Length Tip-To-Tip (mm) | Exit Wire Length (mm) | Nominal Boom Diameter (mm) | Microphone Configuration |
|-----------------|--------|--------------------|----------------------------------|-----------------------------|-----------------------|----------------------------|--------------------------|
| FB-MU-30774-000 | IP51   | DFG-30445-000      | Uni-Directional (Super-Cardioid) | 115                         | 18                    | 1.0                        | 2-Wire                   |
| FB-MU-31024-000 | IP51   | DFG-30851-000      | Noise Canceling                  | 115                         | 18                    | 1.0                        | 2-Wire                   |
| FB-MU-31025-000 | IP57   | VFG-30747-000      | Omni-Directional                 | 115                         | 18                    | 1.0                        | 2-Wire                   |

## W SERIES



- Designed for customers who are looking for small footprint and lightweight platform with waterproofing to 1m (based on IP67 rating)
- Plastic head design with metal flexible boom
- Available in 4.2mm down to 2.7mm diameter metal flexible boom
- Security, Police, Fire dispatchers and other lightweight communication headsets
- SWAT, SRT, HRT, Bike Patrol, Motorcycle Patrol, Mounted and Marine Patrol, K9 Officer
- Designed for the NR and WP elements, but can also accommodate EK and EA series

| Model           | *Rating | †Microphone Element | Directivity     | Boom Length Tip-To-Tip (mm) | Exit Wire Length (mm) | Nominal Boom Diameter (mm) | Microphone Configuration |
|-----------------|---------|---------------------|-----------------|-----------------------------|-----------------------|----------------------------|--------------------------|
| FB-DW-30294-000 | 3m      | WP-25993-D63        | Noise Canceling | 140                         | 60                    | 4.2                        | 2-Wire                   |
| FB-BW-30335-000 | 3m      | WP-25993-D63        | Noise Canceling | 160                         | 60                    | 2.7                        | 2-Wire                   |
| FB-DW-30296-000 | 3m      | WP-25993-000        | Noise Canceling | 140                         | 60                    | 4.2                        | 3-Wire                   |
| FB-DW-30293-000 | IP54 ‡  | NR-25994-D63        | Noise Canceling | 140                         | 60                    | 4.2                        | 2-Wire                   |
| FB-BW-30330-000 | IP54 ‡  | NR-25994-D63        | Noise Canceling | 160                         | 60                    | 2.7                        | 2-Wire                   |
| FB-DW-30295-000 | IP54 ‡  | NR-25994-000        | Noise Canceling | 140                         | 60                    | 4.2                        | 3-Wire                   |

\*Rating done to IP67 test criteria † WP-Series elements are waterproof ‡ Splashproof meeting IP54 test criteria

## O SERIES



- Designed for military customers who are looking for a noise canceling electret element in a metal EMI shielded housing
- Available in Omni-Directional
- Waterproof options down to 3m using WP elements
- Metal head design with metal flexible boom
- Available in 8.0mm down to 4.2mm diameter metal flexible boom
- Military forces, Special Operations, Security, Fire and Police and other communication headsets
- Over the ear, earcup or helmet designs for mounted and non-mounted ground forces
- Designed for the EK, NR and WP elements series

| Model           | *Rating | †Microphone Element | Directivity      | Boom Length Tip-To-Tip (mm) | Exit Wire Length (mm) | Nominal Boom Diameter (mm) | Microphone Configuration |
|-----------------|---------|---------------------|------------------|-----------------------------|-----------------------|----------------------------|--------------------------|
| FB-DO-23511-000 | 3m      | WP-23501-000        | Noise Canceling  | 142                         | 150                   | 4.2                        | 2-Wire                   |
| FB-DO-25946-000 | 3m      | WP-23501-000        | Noise Canceling  | 54                          | 30                    | 4.2                        | 2-Wire                   |
| FB-HO-25624-000 | 3m      | WP-23501-000        | Noise Canceling  | 142                         | 160                   | 5.0                        | 2-Wire                   |
| FB-FO-25581-000 | N/A     | EK-23024-000        | Omni-Directional | 104                         | 140                   | 5.9                        | 2-Wire                   |

\*Rating done to IP67 test criteria † WP-Series elements are waterproof

# SPECIALTY TRANSDUCERS — Booms & Sensors

## F SERIES



- Designed for ruggedized panel mounted applications for outdoor microphone and sensor applications
  - Available in Omni Directional
  - Waterproof options from 1m down to 20m (per IP67, IP68 and MIL-STD-810F)
- Police and Military forces, Special Operations, personalized shot detection systems
  - Sensor arrays for vibration acoustic signatures and triangulation systems
- Designed for the EK, NR and WP elements series

| Model           | *Rating | Microphone Element | Directivity      | Exit Wire Length (mm) | Sensor Diameter (mm) | Microphone Configuration |
|-----------------|---------|--------------------|------------------|-----------------------|----------------------|--------------------------|
| VEK-F-30350-000 | 1m      | EK-23132-C36       | Omni-Directional | 200                   | 16                   | 3-Wire                   |
| VEK-F-30351-000 | 10m     | EK-23132-C36       | Omni-Directional | 200                   | 16                   | 3-Wire                   |
| VEK-F-30352-000 | 20m     | EK-23132-C36       | Omni-Directional | 20                    | 16                   | 3-Wire                   |
| VEK-F-30460-000 | 1m      | EK-23132-C36       | Omni-Directional | 10                    | 16                   | 3-Wire                   |
| VEK-F-30300-000 | 20m     | EK-23132-C36       | Omni-Directional | 8                     | 16                   | 3-Wire                   |
| VEK-F-30470-000 | 1m      | EK-26899-P58       | Omni-Directional | 174 (Shielded)        | 16                   | 3-Wire                   |

\*Rating done to IP67 test criteria

## H SERIES



- Designed for ruggedized fixed position and mounted applications for outdoor sensor arrays for vibration, acoustic signatures and triangulation systems
  - Available in Omni Directional
  - Waterproof options from 1m down to 20m (per IP67, IP68 and MIL-STD-810F)
- Conductive plastic housing designed to pass MIL-STD-810F EMI shielding housing with shielded cable assembly
  - Available with extra high SPL circuit design
  - Custom PCBA options available within the housing cavity
- Military, homeland security, border patrol, Police and local municipality applications
  - Electronic fence, ground sensor / vibration sensor technology, human, light and heavy armored vehicle, helicopter sensors
- Designed for EK, NR, GH and WP series elements

| Model           | *Rating | †Microphone Element | Directivity      | Sensor Length (mm) | Sensor Diameter (mm) | Exit Wire Length (mm) | Microphone Configuration |
|-----------------|---------|---------------------|------------------|--------------------|----------------------|-----------------------|--------------------------|
| VWP-H-30109-000 | 3m      | WP-30113-P03        | Omni-Directional | 21                 | 12.7                 | 211                   | 3-Wire                   |
| VEK-H-30320-000 | 1m      | EK-23169-P03        | Omni-Directional | 21                 | 12.7                 | 211                   | 3-Wire                   |
| VEK-H-30108-000 | 1m      | EK-26899-P03        | Omni-Directional | 21                 | 12.7                 | 211                   | 3-Wire                   |

\*Rating done to IP67 test criteria † WP-Series elements are waterproof

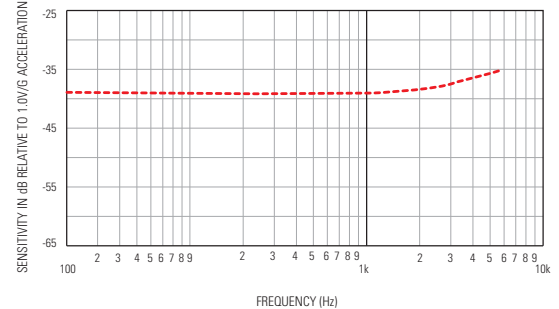
# SPECIALTY TRANSDUCERS — Accelerometers & Acoustic Dampers

## BU SERIES – Accelerometer 7.87 x 5.54 (mm)

BU Series Accelerometers are frequently used as contact microphones for radio communications in high noise environments such as firefighting or combat. The accelerometers reproduce voice signals from vibrations at the throat or from bony parts of the head, and are compatible with helmet or headset applications.



- Ceramic vibration transducer
- High vibration sensitivity
- Small size
- Wide frequency range
- Integral FET amplifier
- High resistance to mechanical shock
- Withstands severe environmental conditions



| Model        | Thickness | Sensitivity @ 1KHz (dB re 1V/g) | DC Supply (V) | Max. Current Drain (uA) | Nominal Output Impedance @1 KHz (Ohms) | "A" Weighted Noise (dBre. 1V) |
|--------------|-----------|---------------------------------|---------------|-------------------------|--|-------------------------------|
| BU-21771-000 | 4.06      | -45.0±4.5                       | 1.5           | 50                      | 5200                                   | -103                          |
| BU-23173-000 | 4.06      | -39.0±4.5                       | 1.5           | 50                      | 5200                                   | -103                          |
| BU-23842-000 | 2.24      | -40.0±4.0                       | 1.5           | 50                      | 5200                                   | -103                          |
| BU-27135-000 | 2.24      | -45.0±4.5                       | 1.5           | 300                     | 5200                                   | -103                          |

## BF Series – Acoustic Damper Screens

Dampers are acoustic cloth screens for insertion inside acoustic tubing. These damping elements are used between the speaker outlet and the ear canal to smoothen the frequency response.



- Smoothen and shape frequency response
- Various acoustical resistances and sizes

| Model       | Color  | Nominal Acoustic Resistance (Ohms) | PLUG (mm) | SCREEN (mm) |
|-------------|--------|------------------------------------|-----------|-------------|
| BF-1859-000 | White  | 680                                | 2.08      | --          |
| BF-1860-000 | Brown  | 1000                               | 2.08      | --          |
| BF-1861-000 | Green  | 1500                               | 2.08      | --          |
| BF-1921-000 | Red    | 2200                               | 2.08      | --          |
| BF-1922-000 | Orange | 3300                               | 2.08      | --          |
| BF-1923-000 | Yellow | 4700                               | 2.08      | --          |
| BF-1988-000 | White  | 680                                | --        | 1.12        |
| BF-1991-000 | Green  | 1500                               | --        | 1.12        |
| BF-1995-000 | Red    | 2200                               | --        | 1.12        |
| BF-1997-000 | White  | 680                                | --        | 1.78        |
| BF-1999-000 | Grey   | 330                                | 2.08      | --          |
| BF-3034-000 | Grey   | 330                                | --        | 1.78        |
| BF-3035-000 | Brown  | 1000                               | --        | 1.78        |
| BF-3036-000 | Orange | 3300                               | --        | 1.78        |
| BF-3037-000 | Red    | 2200                               | --        | 1.78        |
| BF-3038-000 | Green  | 1500                               | --        | 1.78        |
| BF-3039-000 | Green  | 1500                               | --        | 1.37        |
| BF-3163-000 | Yellow | 4700                               | --        | 1.12        |



# SPECIALTY TRANSDUCERS — Speakers

## Specialty Transducer Speakers

Knowles sub-miniature speaker designs are based on balanced armature technology (BAX) and are utilized in a variety of high performance audio and communication products. Knowles balanced armature speakers are available in several sizes and efficiencies, which can be finely tuned to meet your specific performance requirements. They are designed for use in in-ear applications, including earphones and communication earpieces, or be sub-assembled by Knowles for premium consumer electronics accessories.

- High efficiency, stability and reliability
- Customizable performance and port locations
- Ideal for premium in-ear designs
- Component and subassembly solutions

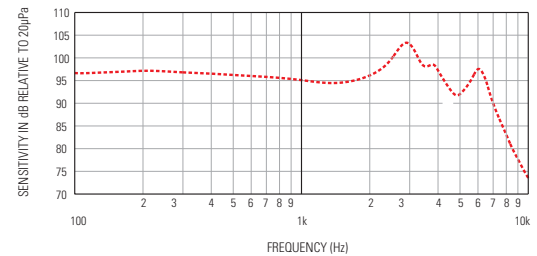


### TWFK SERIES – Dual Balanced Armature Speaker 5.00 x 2.73 x 3.86 (mm)

The world's smallest dual balanced armature speaker, the TWFK is designed for pro-audio in-ear applications. Enables customized cross-over systems to achieve target frequency response in a package size smaller than the ED Series.



- Single sound port for simplified earphone design
- Extreme wideband frequency response
- Unique woofer/tweeter combination
- Enables leading-edge earphone designs for miniature size and performance



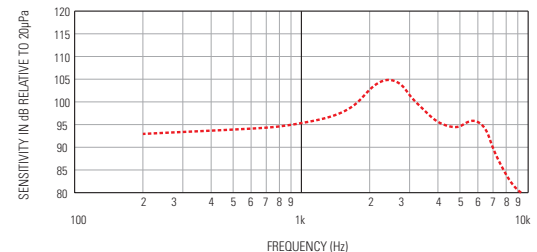
| Model          | Port Location | Sensitivity @ 1 kHz (dB SPL) | Sensitivity @ 1st Peak (dB SPL) | Max SPL @ 1st Peak (dB SPL) | DC Resistance (Ohms) | Impedance @ 500 Hz (Ohms) |
|----------------|---------------|------------------------------|---------------------------------|-----------------------------|----------------------|---------------------------|
| TWFK-30017-000 | 12S           | 95                           | 103                             | 113                         | 25                   | 31                        |

### FK/DFK SERIES – Balanced Armature Speaker 5.00 x 2.73 x 1.93 (mm) (FK), 5.00 X 2.73 X 3.86 (mm) (DFK)

The world's smallest balanced-armature speaker, the FK Series is designed for applications where size is the most important design concern.



- Two-terminal zero-bias configuration
- Undamped, screen damped, and internally damped responses
- Wide range of coil impedances
- DFK model is a dual FK



| Model         | Port Location | Sensitivity @ 1 kHz (dB SPL) | Sensitivity @ 1st Peak (dB SPL) | Max SPL @ 1st Peak (dB SPL) | DC Resistance (Ohms) | Impedance @ 500 Hz (Ohms) |
|---------------|---------------|------------------------------|---------------------------------|-----------------------------|----------------------|---------------------------|
| FK-23451-000  | 12S           | 95.5                         | 108.5                           | 118.5                       | 360                  | 450                       |
| FK-23466-000  | 12S           | 95.5                         | 108.5                           | 118.5                       | 360                  | 450                       |
| FK-26260-000  | 12S           | 96                           | 105                             | 115.5                       | 135                  | 180                       |
| DFK-30041-000 | 12S           | 99.7                         | 105.5                           | 115.5                       | 100                  | 133                       |

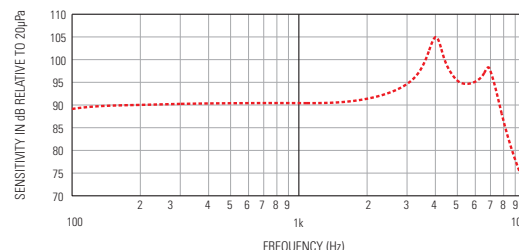
# SPECIALTY TRANSDUCERS — Speakers

## WBFK SERIES – Wideband Balanced Armature Speaker 5.00 x 2.73 x 1.93 (mm)

Same package size as FK Series, WBFK has extended high frequency response. It is recommended as a high frequency component to be combined with low/midrange speaker for music earphones.



- Lower low/mid-band sensitivity compared to FK Series
- Best high frequency response of any Knowles element
- Combine with low/mid-range speaker for extended frequency response
- TWFK pairs WBFK with low frequency FK



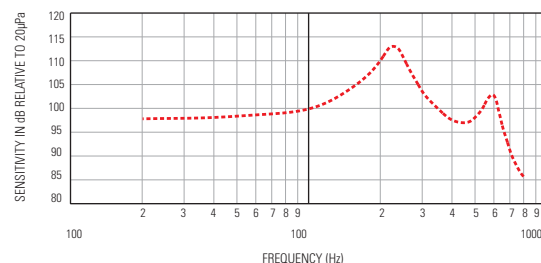
| Model          | Port Location | Sensitivity @ 1 kHz (dB SPL) | Sensitivity @ 1st Peak (dB SPL) | Max SPL @ 1st Peak (dB SPL) | DC Resistance (Ohms) | Impedance @ 500 Hz (Ohms) |
|----------------|---------------|------------------------------|---------------------------------|-----------------------------|----------------------|---------------------------|
| WBFK-30000-000 | 12S           | 95                           | 105                             | 114                         | 100                  | 111                       |
| WBFK-30095-000 | 12S           | 91                           | 105                             | 114                         | 12.5                 | 13.5                      |

## FH SERIES – Balanced Armature Speaker 5.09 x 2.80 x 2.59 (mm)

The FH speaker represents an unprecedented combination of ultra-compact size and high SPL output with efficiencies normally found only in much larger speakers. The FH speaker line brings true high-gain, high-output performance to earphone designs.



- Undamped, screen damped, internally damped, and Ferrofluid™ damped responses
- Various port locations, coil impedances, damping options, termination configurations, and frequency responses available
- Maximum SPL output of 123dB at resonance peak, 109dB at midband (500Hz)\*



| Model        | Port Location | Sensitivity @ 1 kHz (dB SPL) | Sensitivity @ 1st Peak (dB SPL) | Max SPL @ 1st Peak (dB SPL) | DC Resistance (Ohms) | Impedance @ 500 Hz (Ohms) |
|--------------|---------------|------------------------------|---------------------------------|-----------------------------|----------------------|---------------------------|
| FH-23371-000 | 12S           | 100                          | 113                             | 123                         | 60                   | 90                        |
| FH-23375-000 | 12S           | 100                          | 113                             | 123                         | 240                  | 335                       |
| FH-23377-000 | 12S           | 100                          | 113                             | 123                         | 515                  | 685                       |
| FH-23821-000 | 12S           | 100                          | 113                             | 123                         | 125                  | 174                       |
| FH-26553-000 | 12S           | 100                          | 113                             | 123                         | 60                   | 90                        |

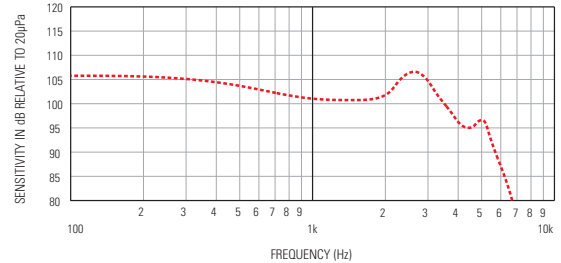
# SPECIALTY TRANSDUCERS — Speakers

## HC SERIES – Balanced Armature Speaker 5.16 x 3.51 x 3.00 (mm)

Knowles balanced-armature, magnetic technology to give high efficiency, stability and reliability. HC Series provides increased low frequency dynamic range in a package size equal to FC.



- High-output technology provides double (+3dB) the maximum acoustic output of existing Knowles FC Series speakers
- Maximum output comparable to Knowles' ED Series speaker in a package size only 68% as large!
- Same size and dimensions as Knowles' EH Series
- Ideal for applications where small size and high output is required



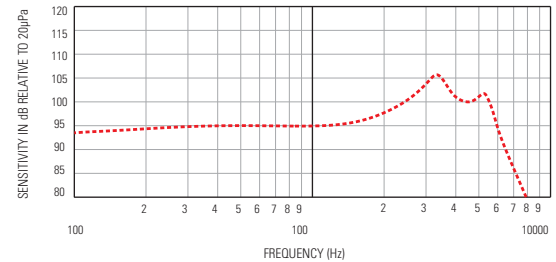
| Model        | Port Location | Sensitivity @ 1 kHz (dB SPL) | Sensitivity @ 1st Peak (dB SPL) | Max SPL @ 1st Peak (dB SPL) | DC Resistance (Ohms) | Impedance @ 500 Hz (Ohms) |
|--------------|---------------|------------------------------|---------------------------------|-----------------------------|----------------------|---------------------------|
| HC-23761-000 | 12C           | 101                          | 107                             | 116                         | 4.9                  | 8.4                       |
| HC-23763-000 | 12C           | 101                          | 107                             | 116                         | 11.5                 | 20                        |
| HC-23764-000 | 12C           | 101                          | 107                             | 116                         | 15.5                 | 24                        |

## WBHC SERIES – Balanced Armature Speaker 5.16 x 3.51 x 3.00 (mm)

The advanced design of the HC Series speaker provides extended acoustic bandwidth for hi-fi in-ear speakers when paired with a low frequency speaker.



- Lower low/mid band sensitivity compared to HC series
- Combine with low/mid-range speaker for extended frequency response



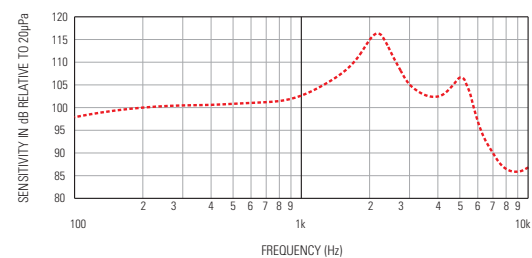
| Model          | Port Location | Sensitivity @ 1 kHz (dB SPL) | Sensitivity @ 1st Peak (dB SPL) | Max SPL @ 1st Peak (dB SPL) | DC Resistance (Ohms) | Impedance @ 500 Hz (Ohms) |
|----------------|---------------|------------------------------|---------------------------------|-----------------------------|----------------------|---------------------------|
| WBHC-23910-000 | 12C           | 95                           | 106                             | 115                         | 120                  | 130                       |

## FC SERIES – Balanced Armature Speaker 5.18 x 3.55 x 3.00 (mm)

FC Series speakers may be used for small radio communication earphones where ED size does meet package requirements. Rounded corners make it slightly smaller compared to EH Series speakers.



- Available in High-Output HC speaker version
- Two-terminal zero-bias and three-terminal center-tapped configurations
- Undamped, screen damped, internally damped, and Ferrofluid™ damped responses
- Rounded corners for improved fit rates; 10% smaller cross-section compared to EH speaker



| Model        | Port Location | Sensitivity @ 1 kHz (dB SPL) | Sensitivity @ 1st Peak (dB SPL) | Max SPL @ 1st Peak (dB SPL) | DC Resistance (Ohms) | Impedance @ 500 Hz (Ohms) |
|--------------|---------------|------------------------------|---------------------------------|-----------------------------|----------------------|---------------------------|
| FC-26171-000 | 12C           | 104                          | 117                             | 127                         | 135                  | 170                       |
| FC-26465-000 | 12C           | 104                          | 117                             | 127                         | 42                   | 57                        |
| FC-26654-000 | 12C           | 104                          | 113                             | 123                         | 40                   | 60                        |
| FC-26887-000 | 12C           | 100                          | 105                             | 116                         | 354                  | 425                       |

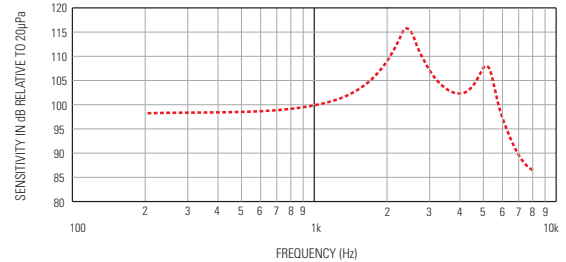
# SPECIALTY TRANSDUCERS — Speakers

## EH SERIES – Balanced Armature Speaker 5.19 x 3.55 x 3.00 (mm)

EH Series speakers are approximately 2/3 the size of ED speakers and may be used for small radio communication earphones where ED size does not meet package requirements.



- *Balanced-armature, magnetic technology to give high efficiency, stability and reliability*
- *High sensitivity*
- *Various responses, including standard, damped and modified*
- *Low distortion*
- *Self-shielded for low magnetic radiation*



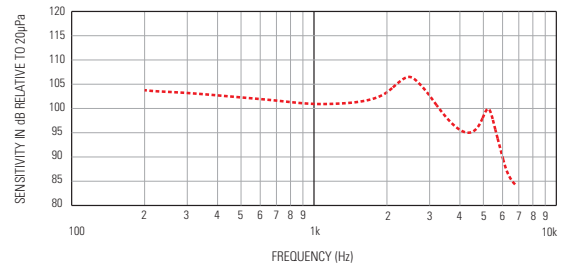
| Model        | Port Location | Sensitivity @ 1 kHz (dB SPL) | Sensitivity @ 1st Peak (dB SPL) | Max SPL @ 1st Peak (dB SPL) | DC Resistance (Ohms) | Impedance @ 500 Hz (Ohms) |
|--------------|---------------|------------------------------|---------------------------------|-----------------------------|----------------------|---------------------------|
| EH-23030-000 | 12C           | 100                          | 117                             | 126.5                       | 395                  | 625                       |
| EH-23149-000 | 12C           | 100                          | 116                             | 126.5                       | 68                   | 101                       |
| EH-27479-000 | 12C           | 100                          | 112.5                           | 123                         | 118                  | 144                       |

## ES SERIES – Balanced Armature Amplified Speaker 5.18 x 3.54 x 3.04 (mm)

EH size speaker with integrated Class D power amplifier.



- *EH micro speaker, but with internal, highly-efficient, class D amplifier*
- *Lower current drain prolongs battery life*
- *Lower distortion*
- *Available in a range of SPL ratings*



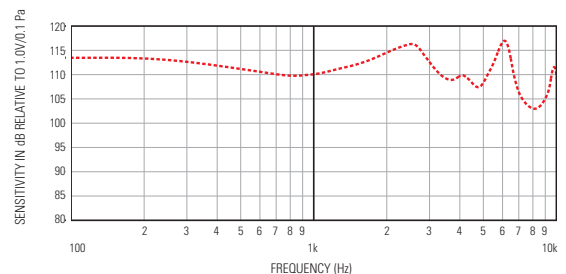
| Model        | Port Location | Sensitivity @ 1 kHz (dB SPL) | Sensitivity @ 1st Peak (dB SPL) | Max SPL @ 1st Peak (dB SPL) |
|--------------|---------------|------------------------------|---------------------------------|-----------------------------|
| ES-23127-000 | 12C           | 101                          | 107                             | 117.5                       |
| ES-23140-000 | 12C           | 101                          | 105.5                           | 115.5                       |

## GQ SERIES – Two-Way Balanced Armature Speaker 6.30 x 4.29 x 4.92 (mm)

The GQ is a two-way balanced armature system with added low frequency headroom, designed for pro-audio in-ear application. Enables customized cross-over response to achieve target frequency response.



- *Dual element with enhanced bass capabilities and wideband response*
- *Unique, subminiature woofer/tweeter combination for in-ear applications*
- *Single port for simplified earphone design*



| Model        | Port Location | Sensitivity @ 1 kHz (db SPL) | Sensitivity @ 1st Peak (db SPL) | Max SPL @ 1st Peak (dB SPL) | DCR  | Impedance @ 500 Hz (Ohms) |
|--------------|---------------|------------------------------|---------------------------------|-----------------------------|------|---------------------------|
| GQ-30783-000 | 12S           | 109.5                        | 116                             | 126                         | 12.5 | 21.5                      |

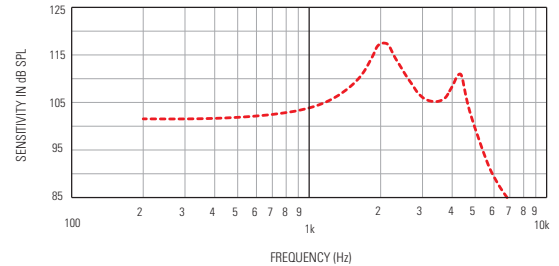
# SPECIALTY TRANSDUCERS — Speakers

## ED SERIES – Balanced Armature Speaker 6.32 x 4.31 x 2.97 (mm)

One of Knowles' most versatile and most popular speakers, its compact size and appreciable output power make the ED speaker suitable for a variety of instruments.



- Undamped, screen damped, internally damped, and Ferrofluid™ damped responses
- Numerous port locations and coil impedances
- High efficiency and low distortion



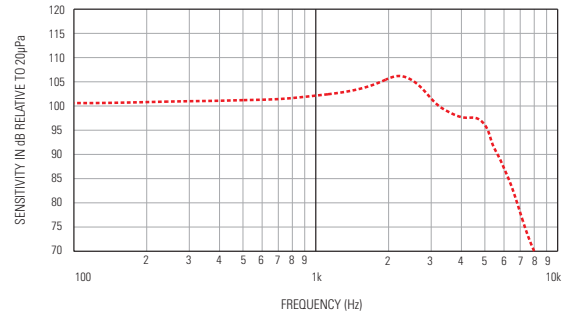
| Model        | Port Location | Sensitivity @ 1 kHz (dB SPL) | Sensitivity @ 1st Peak (dB SPL) | Max SPL @ 1st Peak (dB SPL) | DC Resistance (Ohms) | Impedance @ 500 Hz (Ohms) |
|--------------|---------------|------------------------------|---------------------------------|-----------------------------|----------------------|---------------------------|
| ED-21744-000 | 12C           | 104                          | 112.5                           | 123                         | 825                  | 1700                      |
| ED-21913-000 | 12C           | 104                          | 117.5                           | 127                         | 376                  | 780                       |
| ED-23147-000 | 12C           | 102.5                        | 110                             | 120.5                       | 25                   | 48                        |
| ED-23619-000 | 12C           | 104                          | 117.5                           | 127                         | 3.3                  | 7.1                       |
| ED-23801-000 | 12C           | 104                          | 113                             | 122                         | 155                  | 196                       |
| ED-23814-000 | 12C           | 104                          | 112.5                           | 128                         | 23                   | 50                        |
| ED-26245-000 | 12C           | 104                          | 113                             | 122                         | 35                   | 55                        |
| ED-26598-000 | 12C           | 102.5                        | 106                             | 115.5                       | 196                  | 395                       |
| ED-26821-000 | 12C           | 102.5                        | 111                             | 120.5                       | 3.3                  | 7.1                       |
| ED-27045-000 | 9C            | 104                          | 113                             | 127                         | 196                  | 395                       |
| ED-27230-000 | 12C           | 104                          | 117.5                           | 127                         | 54.5                 | 79                        |
| ED-27304-000 | 12C           | 104                          | 117                             | 127                         | 201                  | 290                       |
| ED-29689-000 | 12C           | 104                          | 118                             | 127                         | 3.7                  | 7.1                       |
| ED-26805-000 | 12C           | 102                          | 110                             | 120                         | 23                   | 26                        |
| ED-26876-000 | 12C           | 102.5                        | 111                             | 121                         | 25                   | 48                        |

## FED SERIES – Balanced Armature Speaker 6.32 x 4.31 x 2.47 (mm)

The addition of *Ferrofluid™* to Knowles ED series speakers improves mechanical shock survival and provides peak damping to smooth frequency response.



- Ferrofluid™ damped with 2dB, 4dB, or 6dB peak amplitude
- Superior shock performance and reduced speaker vibration
- Two-terminal zero-bias and three-terminal center-tapped configurations
- Numerous port locations and coil impedances



| Model         | Port Location | Sensitivity @ 1 kHz (dB SPL) | Sensitivity @ 1st Peak (dB SPL) | Max SPL @ 1st Peak (dB SPL) | DC Resistance (Ohms) | Impedance @ 500 Hz (Ohms) |
|---------------|---------------|------------------------------|---------------------------------|-----------------------------|----------------------|---------------------------|
| FED-26792-I04 | 12C           | 102.5                        | 107                             | 116.5                       | 48                   | 65                        |
| FED-30048-I04 | 12N           | 102                          | 107                             | 116                         | 23                   | 26                        |

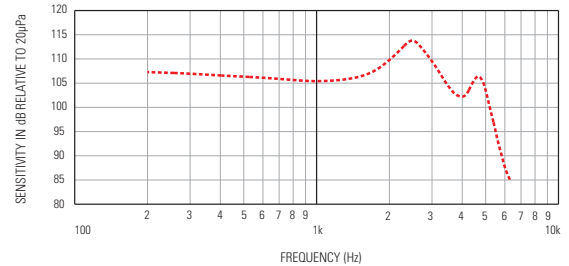
# SPECIALTY TRANSDUCERS — Speakers

## EP SERIES – Balanced Armature Amplified Speaker 6.32 x 4.29 x 2.99 (mm)

Based on Knowles' versatile and popular ED speaker, the EP series adds the benefits of an internal Class-D amplifier. Its compact size and appreciable output power make the EP speaker suitable for a variety of designs.



- Class D amplified magnetic speaker
- Self-shielded to reduce magnetic radiation
- 125dB SPL maximum output
- Three-terminal electrical connection



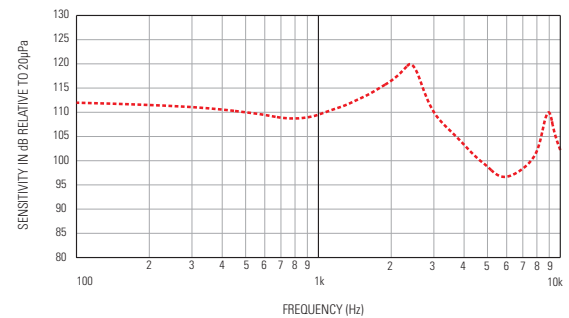
| Model        | Port Location | Sensitivity @ 1 kHz (dB SPL) | Sensitivity @ 1st Peak (dB SPL) | Max SPL @ 1st Peak (dB SPL) |
|--------------|---------------|------------------------------|---------------------------------|-----------------------------|
| EP-24075-000 | 12C           | 106                          | 114                             | 124                         |

## SR SERIES – Balanced Armature Speaker 6.40 DIA x 4.00 (mm)

At 6.4mm diameter, the Mini SR is the smallest round balanced armature speaker in the marketplace. SR offers output equivalent to the FC series and maximizes bass performance.



- Round package facilitates earphone designs
- Drop-in upgrade for moving coil dynamic speakers
- Designed for high volume production
- Balanced armature technology



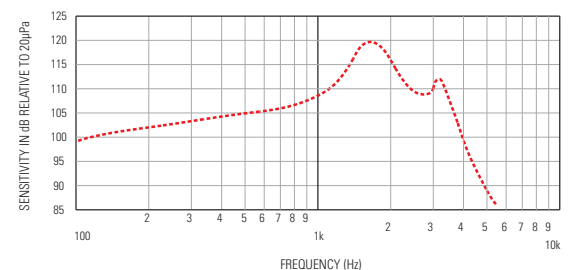
| Model          | Port Location | Sensitivity @ 1 kHz (dB SPL) | Sensitivity @ 1st Peak (dB SPL) | Max SPL @ 1st Peak (dB SPL) | DC Resistance (Ohms) | Impedance @ 500 Hz (Ohms) |
|----------------|---------------|------------------------------|---------------------------------|-----------------------------|----------------------|---------------------------|
| SR-6438NWS-000 | Face          | 109.5                        | 120                             | 130                         | 25                   | 36.5                      |
| SR-6438NWS-158 | Face          | 109.5                        | 120                             | 130                         | 25                   | 32.8                      |

## EC SERIES – Balanced Armature Speaker 7.57 x 4.31 x 3.67 (mm)

EC Series speakers are commonly used in isolating earphones for radio communication.



- Similar SPL output to the BK Series
- Rounded corners on the face opposite the terminal pad
- 34% smaller volume than the BK Series



| Model        | Port Location | Sensitivity @ 1 kHz (dB SPL) | Sensitivity @ 1st Peak (dB SPL) | Max SPL @ 1st Peak (dB SPL) | DC Resistance (Ohms) | Impedance @ 500 Hz (Ohms) |
|--------------|---------------|------------------------------|---------------------------------|-----------------------------|----------------------|---------------------------|
| EC-23097-000 | 12S           | 108                          | 120                             | 130                         | 92                   | 200                       |
| EC-23098-000 | 12S           | 108                          | 120                             | 130                         | 196                  | 425                       |
| EC-26368-000 | 12S           | 108                          | 120                             | 129                         | 26.3                 | 54                        |

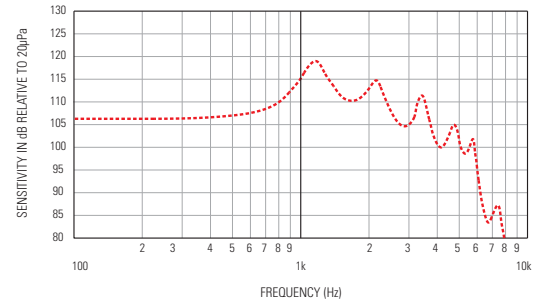
# SPECIALTY TRANSDUCERS — Speakers

## TEC SERIES – Balanced Armature Speaker 7.87 x 4.09 x 2.79 (mm)

The TEC combines output comparable to the larger BK speaker in an ultra-thin package. The TEC is suitable for multi-element earphone designs.



- Ultra-thin
- Wideband output
- DTEC combines two TEC elements
- Enables small multi-element designs



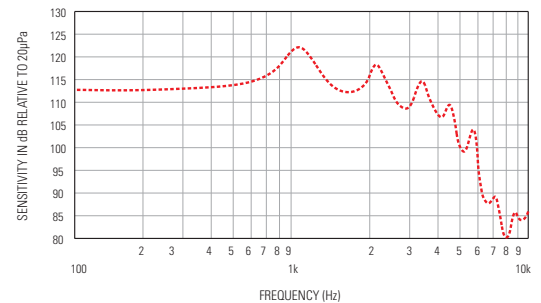
| Model         | Port Location | Sensitivity @ 1 kHz (dB SPL) | Sensitivity @ 1st Peak (dB SPL) | Max SPL @ 1st Peak (dB SPL) | DC Resistance (Ohms) | Impedance @ 500 Hz (Ohms) |
|---------------|---------------|------------------------------|---------------------------------|-----------------------------|----------------------|---------------------------|
| TEC-30033-000 | 12C           | 115                          | 119                             | 129                         | 22                   | 31                        |
| TEC-30087-000 | 12C           | 115                          | 119                             | 129                         | 46                   | 62                        |

## DTEC SERIES – Balanced Armature Speaker 7.87 x 4.09 x 5.59 (mm)

The DTEC Series combines two TEC speaker elements with a single round port. Case size is equivalent to BK/EF. DTEC provides increased output and reduced vibration compared to a single speaker.



- Dual elements with single sound port
- More output than BK in equal package size
- Reduced vibration compared to BK
- Improved frequency response compared to BK



| Model          | Port Location | Sensitivity @ 1 kHz (dB SPL) | Sensitivity @ 1st Peak (dB SPL) | Max SPL @ 1st Peak (dB SPL) | DC Resistance (Ohms) | Impedance @ 500 Hz (Ohms) |
|----------------|---------------|------------------------------|---------------------------------|-----------------------------|----------------------|---------------------------|
| DTEC-30008-000 | 12S           | 123                          | 122.5                           | 132.5                       | 23                   | 31.5                      |

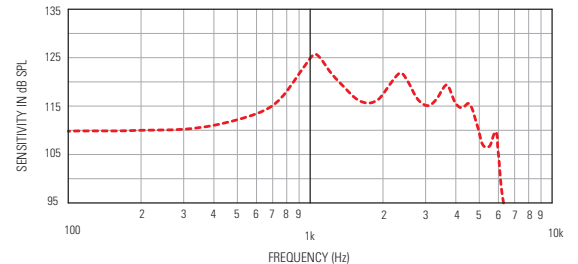
# SPECIALTY TRANSDUCERS — Speakers

## BK SERIES – Balanced Armature Speaker 7.87 x 5.59 x 4.01 (mm)

BK Series speakers provide broadband performance at value pricing. They are commonly used for full range in-ear speakers and communications utilizing an earplug design.



- High efficiency and low distortion
- Various port locations, coil impedances, damping options, terminal configurations, and frequency responses available



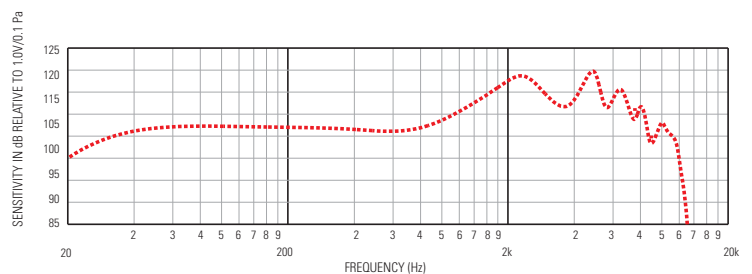
| Model        | Port Location | Sensitivity @ 1 kHz (dB SPL) | Sensitivity @ 1st Peak (dB SPL) | Max SPL @ 1st Peak (dB SPL) | DC Resistance (Ohms) | Impedance @ 500 Hz (Ohms) |
|--------------|---------------|------------------------------|---------------------------------|-----------------------------|----------------------|---------------------------|
| BK-21600-000 | 12S           | 123                          | 125                             | 133                         | 100                  | 285                       |
| BK-21604-000 | 12S           | 123                          | 125                             | 133                         | 895                  | 2320                      |
| BK-21610-000 | 12S           | 121                          | 126                             | 136                         | 21                   | 60                        |
| BK-21613-000 | 1S            | 118                          | 125                             | 134                         | 160                  | 450                       |
| BK-21615-000 | 12S           | 118                          | 125                             | 134                         | 160                  | 450                       |
| BK-21669-000 | 12C           | 123.5                        | 125                             | 134                         | 9                    | 22                        |
| BK-23134-000 | 12S           | 118                          | 125                             | 134                         | 100                  | 285                       |
| BK-26824-000 | 12S           | 119                          | 120                             | 129                         | 10.7                 | 16                        |
| BK-28507-000 | 12S           | 126                          | 126                             | 136                         | 10.7                 | 13.3                      |
| BK-28510-000 | 12S           | 123                          | 127                             | 135                         | 111                  | 320                       |
| BK-28562-000 | 12S           | 123                          | 124                             | 131                         | 18.5                 | 23                        |
| BK-29725-000 | 12S           | 118                          | 119                             | 128                         | 100                  | 285                       |

## GP SERIES – Two-Way Balanced Armature Speaker 7.90 x 4.29 x 5.76 (mm)

The GP is a two-way balanced armature system with high output capabilities for professional in-ear applications. Enables customized cross-over response to achieve target frequency response.



- High performance, low-profile two-way system
- Customizable cross-over capabilities
- Dual ported to mechanically tune each driver



| Model        | Port Location | Sensitivity @ 1 kHz (dB SPL) | Sensitivity @ 1st Peak (dB SPL) | Max SPL @ 1st Peak (dB SPL) | DC Resistance (Ohms) | Impedance @ 500 Hz (Ohms) |
|--------------|---------------|------------------------------|---------------------------------|-----------------------------|----------------------|---------------------------|
| GP-30711-000 | 12S (Dual)    | 108.5                        | 118                             | 128                         | 58                   | 67                        |



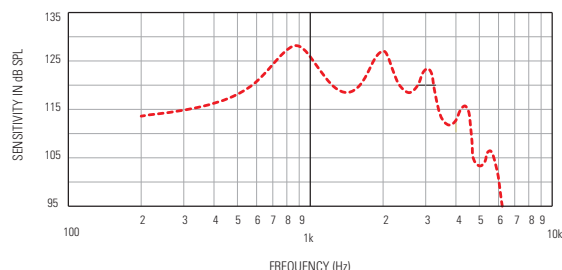
# SPECIALTY TRANSDUCERS — Speakers

## CI SERIES – Balanced Armature Speaker 9.47 x 7.18 x 4.10 (mm)

Knowles' largest and most powerful speaker, the CI series is the speaker of choice. With its high efficiency and a 143dB SPL maximum output, the CI speaker provides optimal low frequency performance.



- Two-terminal zero-bias and three-terminal center-tapped configurations
- Various port locations, coil impedances, termination configurations, and frequency responses available



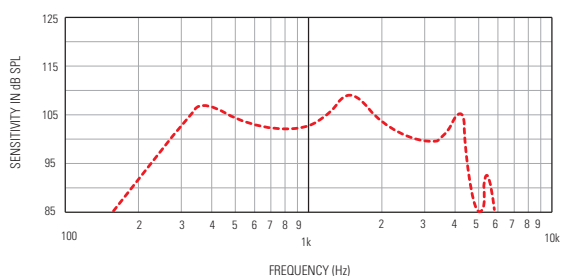
| Model        | Port Location | Sensitivity @ 1 kHz (dB SPL) | Sensitivity @ 1st Peak (dB SPL) | Max SPL @ 1st Peak (dB SPL) | DC Resistance (Ohms) | Impedance @ 500 Hz (Ohms) |
|--------------|---------------|------------------------------|---------------------------------|-----------------------------|----------------------|---------------------------|
| CI-22748-000 | 12C           | 125                          | 128                             | 138.5                       | 75                   | 250                       |
| CI-22762-000 | 1S            | 125                          | 128                             | 138.5                       | 51                   | 175                       |
| CI-22955-000 | 12C           | 125                          | 128                             | 138.5                       | 20                   | 68 @ 1kHz                 |
| CI-22960-000 | 12C           | 125                          | 128                             | 138.5                       | 100                  | 400                       |
| CI-28487-000 | 1S            | 125                          | 128                             | 138.5                       | 24                   | 100 @ 1kHz                |
| CI-28597-000 | 11S           | 125                          | 128                             | 138.5                       | 20                   | 68 @ 1kHz                 |

## CM SERIES – Balanced Armature Speaker 8.38 x 16.64 DIA (mm)

The CM Series delivers the benefits of balanced armature technology in a compact finished package. The CM is ideal for use in situations where a non-contacting headset is required, but signal voltage is limited – as is common for radios and wireless telephones. The CM also conserves battery power, and provides static shock protection for the user.



- Balanced-armature, magnetic technology to give high efficiency, stability and reliability
- High acoustic efficiency enables sufficient sound output even when limited power is available
- In-built static protection
- Lightweight, matt-black, plastic housing
- Ergonomically designed with rounded edge to fit the concha
- High-quality sound output
- Tailored bandwidth for superb speech intelligibility



| Model        | Port Location | Sensitivity @ 1 kHz (dB SPL) | Sensitivity @ 1st Peak (dB SPL) | Max SPL @ 1st Peak (dB SPL) | DC Resistance (Ohms) | Impedance @ 500 Hz (Ohms) |
|--------------|---------------|------------------------------|---------------------------------|-----------------------------|----------------------|---------------------------|
| CM-23152-000 | Face          | 103                          | 109                             | 119                         | 69                   | 150                       |
| CM-23299-000 | Face          | 103                          | 109                             | 119                         | 69                   | 150                       |
| CM-28421-000 | Face          | 103                          | 109                             | 119                         | 100                  | 360                       |
| CM-28431-000 | Face          | 103                          | 109                             | 119                         | 10.5                 | 30                        |
| CM-28452-000 | Face          | 103                          | 109                             | 119                         | 100                  | 360                       |

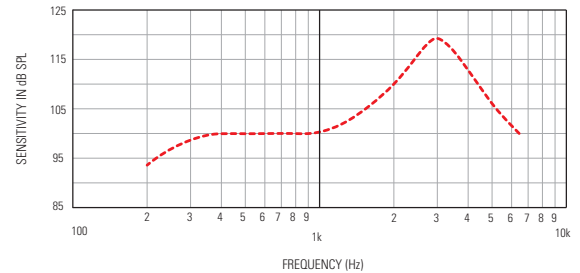
# SPECIALTY TRANSDUCERS — Speakers

## MR SERIES – Waterproof Speaker 22.12 DIA x 9.3 (mm)

The MR Series Assemblies consist of a speaker element attached to a waterproof bellows assembly. They may be panel mounted, and are suitable for outdoor use or repeated submersion.



- Highly waterproof – no loss of performance after immersion in 15m water
- Corrosion resistant
- Withstands explosive decompression
- Design proven in rugged environments
- Leads attached
- High resistance to mechanical shock
- Acoustically transparent bellows
- Resists effects of mud, sand, and salt encrustation



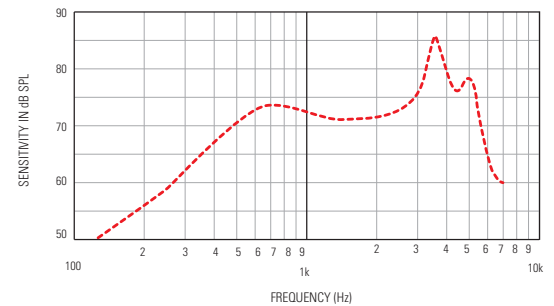
| Model        | Port Location | Sensitivity @ 1 kHz (dB SPL) | Sensitivity @ 1st Peak (dB SPL) | Max SPL @ 1st Peak (dB SPL) | DC Resistance (Ohms) | Impedance @ 500 Hz (Ohms) |
|--------------|---------------|------------------------------|---------------------------------|-----------------------------|----------------------|---------------------------|
| MR-23333-000 | Face          | 100                          | 119.5                           | 129                         | 10                   | 21                        |

## CB SERIES – Balanced Armature Speaker 25.15 x 25.15 x 9.65 (mm)

The CB Series Transceiver offers high electro-acoustic efficiency to conserve power in push-to-talk radio handsets and other battery operated equipment. The CB is available with mounting pins to facilitate assembly to a PC board. Model CB-23817-000 is designed to survive submersion in water.



- Excellent sound quality
- High speech intelligibility, stability, and reliability
- Suitable for PCB mounting
- Can function as a microphone or beeper
- Various impedances
- Face and edge port locations available



| Model        | Port Location | Sensitivity @ 1 kHz (dB SPL) | Sensitivity @ 1st Peak (dB SPL) | Max SPL @ 1st Peak (dB SPL) | DC Resistance (Ohms) | Impedance @ 500 Hz (Ohms) |
|--------------|---------------|------------------------------|---------------------------------|-----------------------------|----------------------|---------------------------|
| CB-22849-000 | Edge          | 73                           | 86                              | 96.5                        | 11.5                 | 24                        |
| CB-22850-000 | Edge          | 73                           | 86                              | 96.5                        | 21.5                 | 48                        |
| CB-23817-000 | Edge          | 83                           | 97                              | 107                         | 21.5                 | 48                        |

# CUSTOM ASSEMBLIES

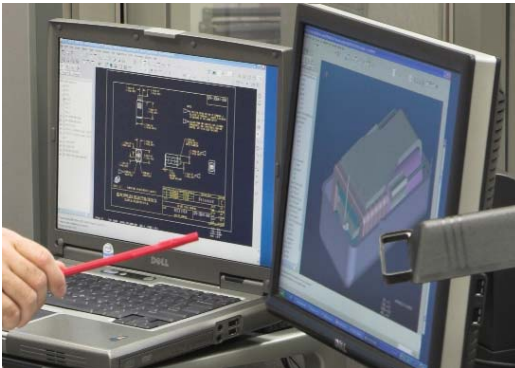
## FINISHED GOODS

Wherever your design ideas take you, Knowles Acoustics can support your need for customized audio assemblies. Our custom Finished Goods offer a turnkey solution utilizing the acoustic expertise and components of Knowles Acoustics.



## COMPLETE SOLUTION

Knowles Acoustics Finished Goods program offers reduced time to market at an ultimately reduced total manufacturing cost of acoustic product ownership. Support in design, application, assembly and testing are all elements included in our services. Off-the-shelf designs are also available.



- Design Support
- Industrial
  - Mechanical
  - Application Tuning



- Manufacturing Services
- Assembly
  - Cabling
  - Testing
  - Utilization of Knowles Acoustic components

## MARKET APPLICATIONS

Ultimately, our mission is to improve the acoustic interface and simplify the manufacturing process for customers. Our long term acoustic history provides the expertise for markets and customers of:

- Mobile media products
- Industrial communications
- Consumer electronics applications

## MARKET MATRIX

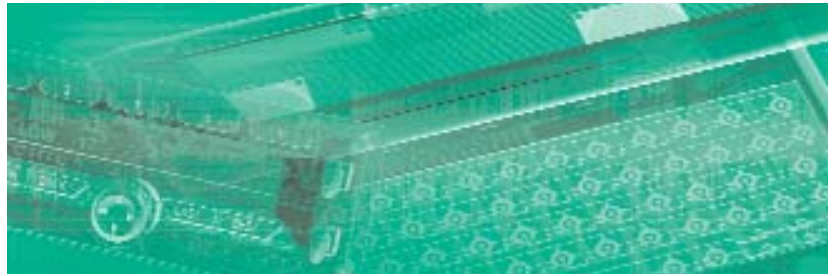
| Assembly Designs | MP3 | Mobile Phone | Smart Phone/PDA | Notebook | Industrial Comm. |
|------------------|-----|--------------|-----------------|----------|------------------|
| Single Ear       |     | ✓            | ✓               |          | ✓                |
| Stereo           | ✓   | ✓            | ✓               | ✓        | ✓                |
| Microphone       |     | ✓            | ✓               | ✓        | ✓                |

Collaborate in-depth with Knowles Acoustics to arrive at an integrated component and assembly design to manufacture for you.

# ACOUSTIC SOFTWARE

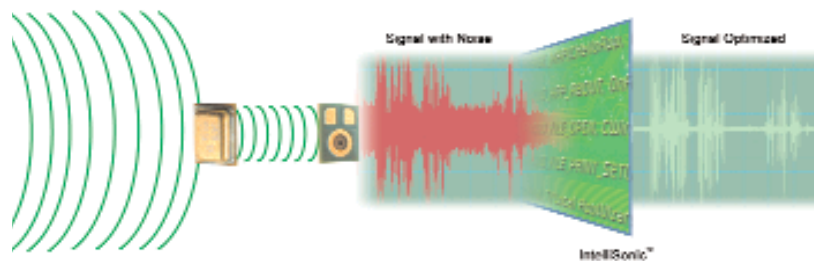
## INTELLISONIC™

The intelligibility and use of mobile communications are often impeded by the impact of noise from the immediate environment. IntelliSonic is a software-based speech enhancement technology that when coupled with Knowles' microphones, reduces the effects of reverberation, directionally interfering speech, background noise and annoying acoustic echo.



## COMPLETE SOLUTION – Integrated Systems

When you consider the interdependency of microphone design, acoustic porting, and sound signal conditioning, it's easy to see why Knowles Acoustics has taken an integrated approach to your acoustic system needs.



## FEATURES

- Noise suppression 12dB-16dB
- Interference cancellation via beam-forming array 25dB
- Acoustic echo cancellation 25dB
- Speech bandwidth 8kHz
- Adjustable acceptance and look angles
- Fully adaptive system adapts to changing acoustic environment
- Rich application programming interface (API) set
- Real-time processing
- Low speech distortion

## APPLICATIONS

Platforms such as tablets, laptops, ultra-mobile personal computers (UPCs), and other mobile computing devices have a number of applications that would benefit from IntelliSonic to enhance the user experience and final product perception.

- VoIP Telephony
- Command and Control
- Voice recognition
- Dictation
- Language Translation
- Voice Annotation
- Audio Note Taking

## PRODUCT MATRIX

| Product Code | # of Microphones | Noise Reduction | Array Processing | Echo Cancellation |
|--------------|------------------|-----------------|------------------|-------------------|
| DXEC01       | 1                | ✓               | –                | ✓                 |
| DXEC02       | 2                | ✓               | ✓                | ✓                 |



(Visual output of recordings using same microphone)

## SUPPORTED PLATFORMS (OS Support)

| OS   | Model  | Codec                       |
|--|--|-----------------------------|
| Microsoft Windows XP/2000                    | WDM Upper Filter   | AC'97 and HDAudio           |
| Microsoft Windows 7/Vista                    | WaveRT APO   | AC'97, HDAudio and USBAudio |
| Microsoft Windows Mobile and its Derivatives | Static library or integrated into codec driver binary (requires customization) |                             |

## LICENSING

Evaluation licenses are available upon signing an NDA and Software Evaluation Agreement. Volume Licensing is available for OEM products. Please contact Knowles Sales Representatives for terms.

# MICROPHONE AND SPEAKER BASICS

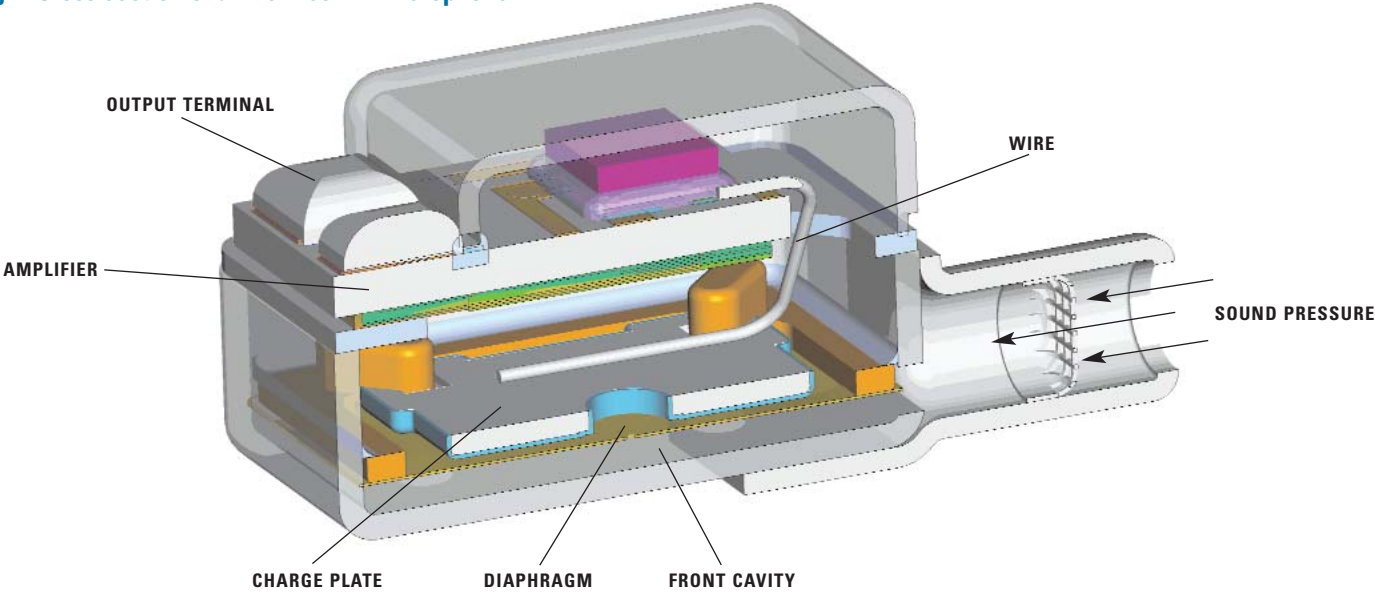
## MICROPHONES

Microphones measure sound pressure. Inside a Knowles microphone is a thin flexible diaphragm, an electrically charged plate, and an amplifier (Fig. 1). The output voltage is proportional to changes in the small separation between the diaphragm and the charged plate (Fig. 2).

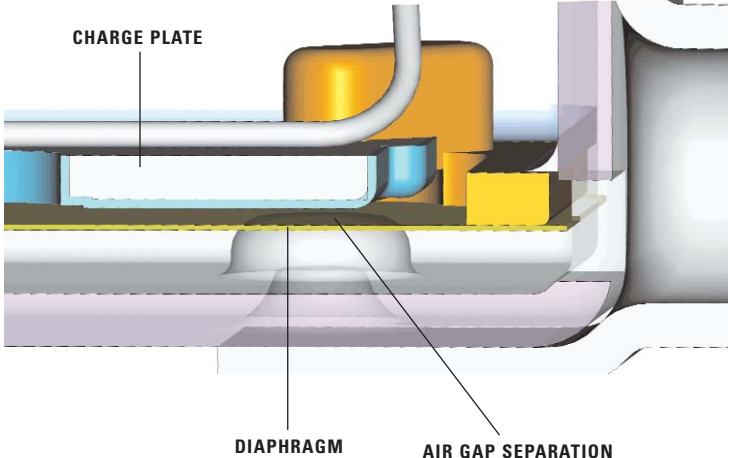
As sound pressure inside the front cavity increases, the diaphragm is pushed closer to the plate. As the pressure decreases, it moves further away. The motion of the diaphragm produces a small electrical signal that is amplified by a miniature circuit inside the microphone.

The sensitivity of a typical Knowles' microphone is measured in units of dB relative to 1 Volt per 0.1 Pascal.

**Fig 1: Cross section of a Knowles EM microphone**



**FIG. 2: EM diaphragm and electret**



# MICROPHONE AND SPEAKER BASICS

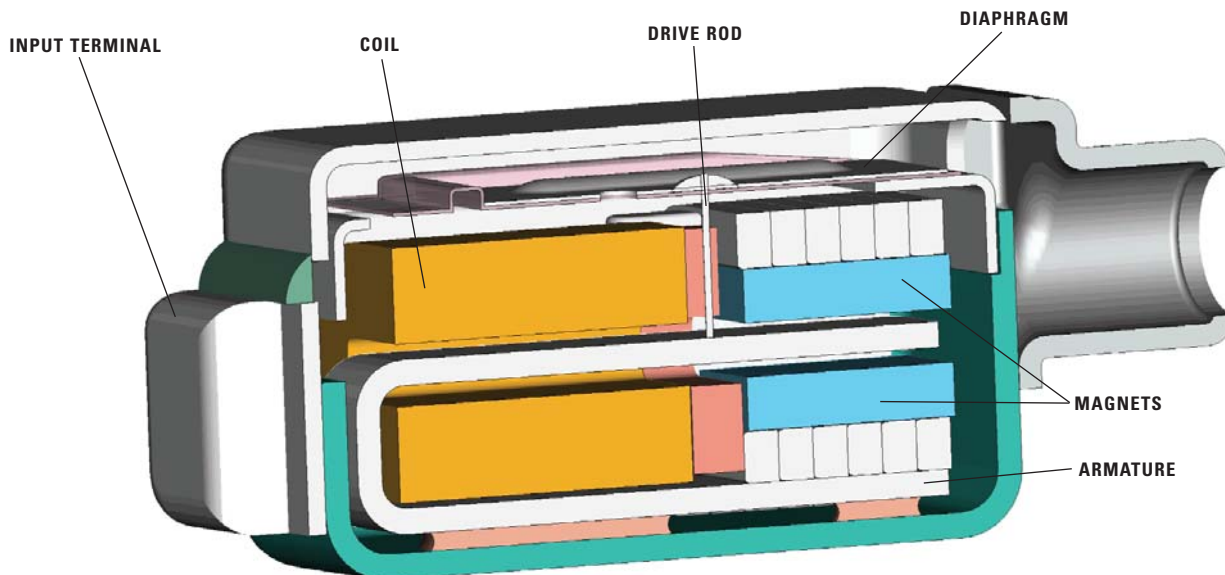
## SPEAKERS

The speaker converts an electrical signal into sound. A cross section of a typical Knowles speaker is shown in Fig. 3. The basic components of the speaker are: a coil of wire, a metal U-shaped reed called the armature, a pair of permanent magnets, a drive rod, and a diaphragm.

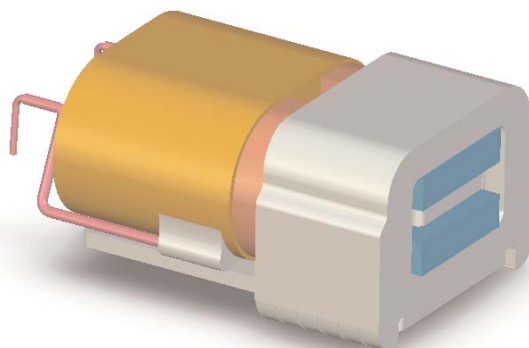
The coil and armature act as an electromagnet. An alternating current in the coil causes the polarity of the armature to switch back and forth from north to south. The free end of the armature bends slightly up and down as it is attracted alternately to the top and bottom magnets (Fig. 4). The diaphragm, pulled along by the drive rod, pumps air in and out of the speaker. The mechanical motion of the armature is thus converted into sound.

The sound output of a typical Knowles' speaker is measured in units of dB SPL (sound pressure level) relative to 20  $\mu$ Pa.

**Fig. 3: Cross section of a Knowles EH speaker**



**Fig. 4: The motor of the speaker has a coil, an armature, and a pair of permanent magnets.**





# Globally Positioned

AMERICAS

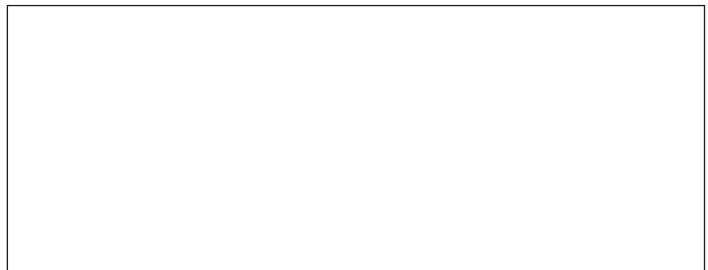
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