Knowles®

TB9

BT CONDENSER MICROPHONE 2-WIRE APPLICATION NOTES

The BT microphone is designed to be used in a normal (3-wire) circuit, as described by Figures 1 and 2.
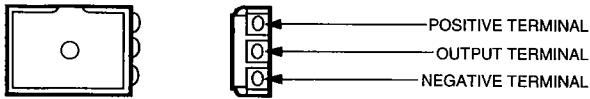

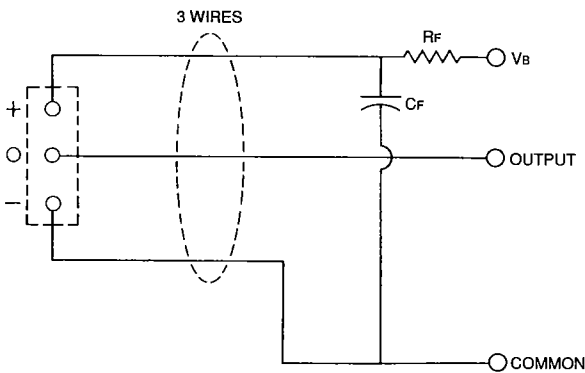FIGURE 1. BT-1750 Microphone, outline drawing.

POSITIVE TERMINAL
OUTPUT TERMINAL
NEGATIVE TERMINAL

FIGURE 2. Normal Three-Wire circuit.

The purpose of R_F and C_F, in Figure 2, is to decouple the power supply. The value of R_F should not be higher than 2000 Ohms to prevent an excessive voltage drop across it. The value of C_F should be at least $1\mu F$.

With 1.3 Volts impressed across the "+" and "-" terminals of the microphone, the 1kHz open circuit sensitivity of a BT-1750 microphone is -60 ±3 dB re 1.0 Volt per μbar. The equivalent vibration sensitivity is 70dB (1kHz SPL equivalent of 1G), and the nominal A-weighted noise level is 26dB (1kHz SPL equivalent of noise).

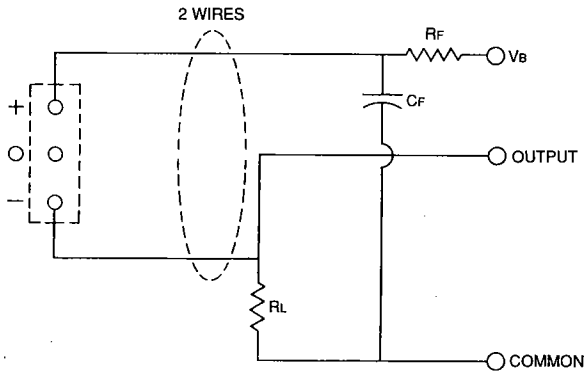To adapt the BT microphone to 2-wire use, the circuit shown in Fig. 3, or some variation of it, can be used.

FIGURE 3. Typical Two-Wire circuit.

The two circuits shown above as Figures 2 and 3 produce acoustical signals of the same phase. However the circuit has the liability of the microphone housing being connected to the off ground output terminal. This must be considered when mounting the transducer. Since the microphone housing is not at what would normally be considered the ground potential and in fact is connected to the amplifier input terminal, the possibility of feedback is enhanced.

The purpose of R_F and C_F again is the same as in the normal circuit and will not affect the performance of the circuit except for the voltage drop across R_F, which will be discussed in the paragraph on battery voltage requirements. The supply voltage impressed across the "+" and "-" terminals of the microphone is 1.3V, unless stated otherwise. Fig. 4 shows the calculated 1kHz sensitivity variation, into a high impedance amplifier, as a function of R_L.

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EXAMPLE: If the value of RL is 4000 Ohms, the 1kHz sensitivity into a high impedance amplifier in the 2-wire mode will be approximately -76 ±5 dB re 1 Volt per µbar.
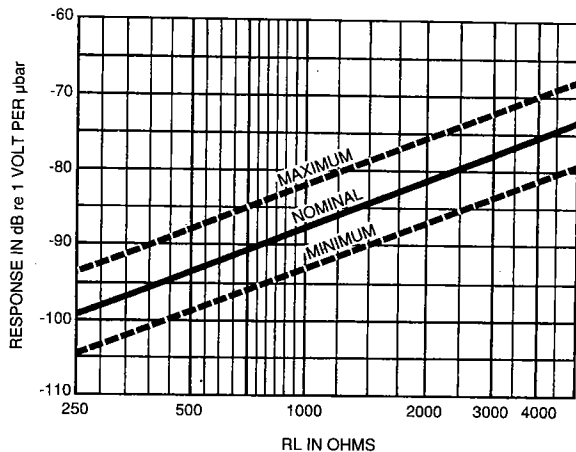

FIGURE 4. Calculated 1KHz sensitivity limits for BT Microphones used in the 2-Wire mode.

An alternative circuit, as shown below in Figure 5, has the advantage of having the microphone housing at ground potential. It has a disadvantage though in that power supply feed-through is an order of magnitude higher. The phase of the output signal is reversed from that in Figure 3.

To increase the sensitivity and to obtain a low frequency rolloff, a capacitor or capacitor and resistor combination can be connected from the "0" to the "-" terminal but this will provide
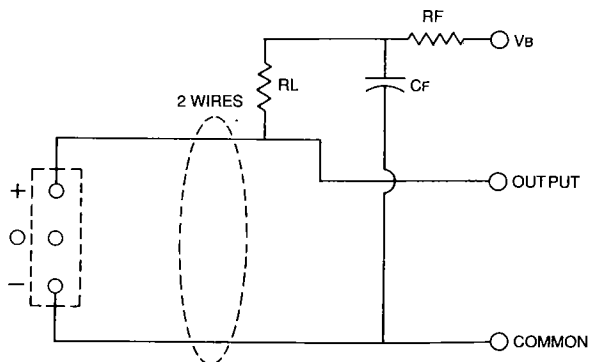

FIGURE 5. Alternate Two-Wire circuit

the two-wire circuitry only if the resistor and capacitor can be physically associated with the microphone. However a disadvantage of this method is the large variation expected in the 1kHz sensitivity between microphones. This circuit is shown below in Figure 6.

EXAMPLE: Using a 0.22 µF capacitor, without a series resistor, will give a 1kHz sensitivity at RL, (RL = 4000 Ohms) into a high impedance amplifier, of approximately -62 ±7dB re 1 Volt per µbar and an additional 3dB rolloff at approximately 200 Hz due to the 0.22 µF capacitor.
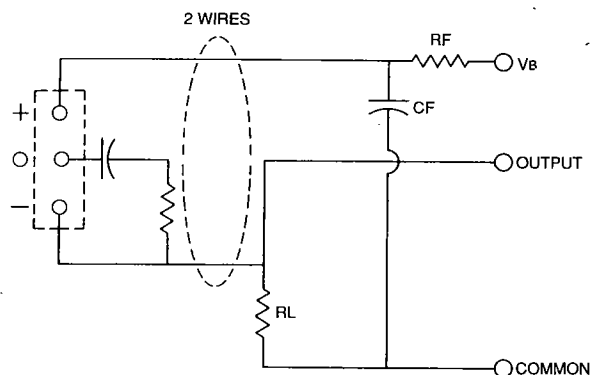

FIGURE 6. Alternate Two-Wire circuit.

The sensitivity variation can be decreased by using a resistor in series with the capacitor across the "0" and "-" terminals of the microphone.

EXAMPLE: A 10K Ohm resistor in series with a 0.22 µF capacitor will give a 1kHz sensitivity at RL, (RL = 4000 Ohms) into a high impedance amplifier of -68 ±6dB re 1 Volt per µbar. There is no noticeable additional rolloff due to the 0.22 µFcapacitor. Knowles' microphone sensitivities are ususally specified with 1.3 Volts DC impressed directly across the "+"and "-" terminals of the microphone.

Referring to Figs. 2 and 3, the voltage actually impressed across the terminals of the microphone will depend upon the battery voltage V_B, the value of resistances R_F and R_L, and the microphone drain current. The specified maximum current drain of BT microphones is 50 microamperes. In order to be sure that all BT microphones operate properly in the 2-wire mode, the "end of life" battery voltage must not be less than the value given by:

V_B (End-of-Life)
$= 0.9$ V $+ (50\mu A)$ $(R_F + R_L)$ Ohms

Fig. 7 shows the "End-of-Life" battery voltage as the total resistance of the circuit between the microphone and the battery is varied. In actual practice, it will be found that most BT microphones will be able to operate satisfactorily with battery voltages less than the calculated "end-of-life" value because most BT microphones are able to provide the specified sensitivities at lower terminal voltages than 0.9 Volts, and because most BT microphones require substantially less drain current than the 50 microampere maximum drain current specified.

EXAMPLE: With typical resistance values of
$R_F = 2000$ Ohms and
$R_L = 4000$ Ohms,
V_B (end-of-life)
$= 0.9$ V $+ (50 \mu A) (6000$ Ohms$)$
$= 0.9 + 0.3$
$= 1.2$ Volts.
If a drain current of 25 μA (as is common) is used to determine the "end-of-life" battery voltage for a particular BT, it can be demonstrated why 2-wire microphones frequently operate satisfactorily well below the battery voltage of 1.2 Volts:

$V_B = 0.9$ V $+ (25 \mu A)$ $(6000$ Ohms$)$
$= 0.9$ V $+ 0.15$ V
$= 1.05$ Volts.
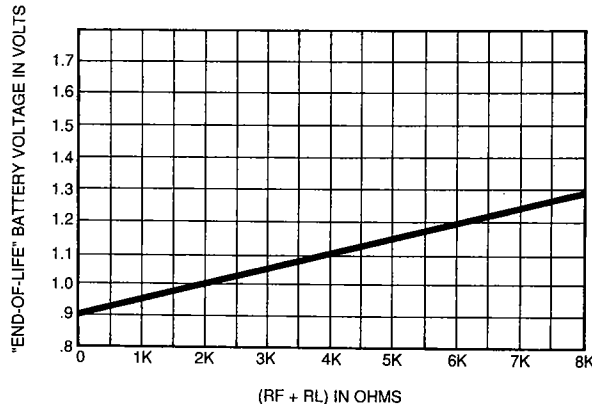

FIGURE 7. "End-of Life" Battery voltage required vs. (R_F+R_L)

The shape of the frequency response of the BT microphones in the 2-wire mode is the same as in the normal mode; however, there will be a low frequency rolloff if a capacitor is installed between the "0" and "-" terminals of the microphone. The relative vibration sensitivity and the relative noise level will be the same in the 2-wire mode as in the normal 3-wire mode.