# BA1602AL

## FM intercom

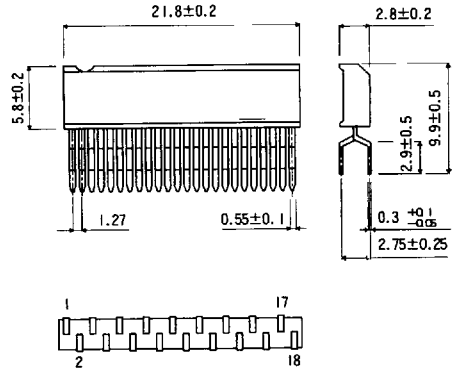
The BA1602AL IC is designed to be used in FM intercoms.

### Features

- available in a ZIP18 package
- operating voltage range is very wide (6 ~ 10 Vdc)
- low current consumption
- since it uses a PLL system, it is easy to tune and is very stable
- built in squelch function, with hysteresis. Sensitivity of the squelch is independent of the degree of modulation
- output of the VCO is a sine wave with a very small harmonic content allowing it to be used for transmission
- capture and lock ranges are independent of the tuned central frequency
- tone canceller circuit is included, allowing use in tone-type intercoms

### Dimensions (Units : mm)

**BA1602AL (ZIP18)**




### Applications

- FM intercom systems, 2-way call and press-to-talk
- tone decoders

### Absolute maximum ratings ($T_a$ = 25°C)

| Parameter | Symbol | Limits | Unit | Conditions |
|---|---|---|---|---|
| Power supply voltage | $V_{CC}$ | 10 | V | |
| Power dissipation | $P_d$ | 400 | mW | Reduce power by 4 mW/°C for each degree above 25°C. |
| Operating temperature | $T_{opr}$ | −25 ~ 60 | °C | |
| Storage temperature | $T_{stg}$ | −55 ~ 125 | °C | |

### Recommended operating conditions (T = 25°C)

| Parameter | Symbol | Min | Typical | Max | Unit |
|---|---|---|---|---|---|
| Power supply voltage | $V_{CC}$ | 6 | 8 | 10 | V |
| Central frequency | $f_0$ | | | 450 | kHz |



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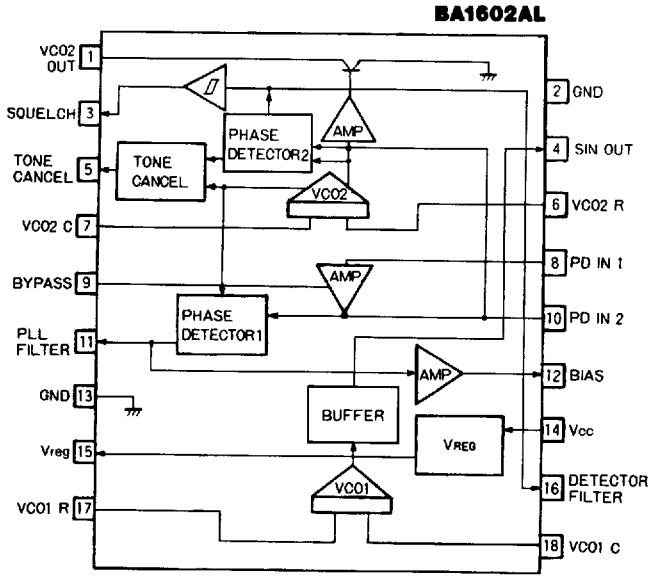
## Block diagram




## Electrical characteristics unless otherwise noted, ($T_a$ = 25°C, $V_{CC}$ = 6 V)

| Parameter | Symbol | Min | Typical | Max | Unit | Conditions |
|---|---|---|---|---|---|---|
| Maximum center frequency | $f_{0MAX}$ | 450 | | | kHz | |
| Quiescent current | $I_Q$ | 9.5 | 12.5 | 19 | mA | No signal |
| Detector output | $V_{RO}$ | 20 | 28 | 36 | mV | $V_{IN}$ = 60 dBμV, 450 kHz<br>Δf = 2 kHz, $f_m$ = 400 Hz |
| Detector output distortion | THD | | 2 | 4 | % | $V_{IN}$ = 60 dBμV, 450 kHz<br>Δf = 10 kHz, $f_m$ = 1 kHz |
| Sine wave distortion | $THD_{sine}$ | | 6 | 9 | % | Pin 4 140 Hz |
| Detector sensitivity | S | 120 | 220 | 20 | μV | Squelch on level |
| Input resistance | $R_{IN}$ | 6 | 10 | 13 | kΩ | Pin 8 1 kHz |



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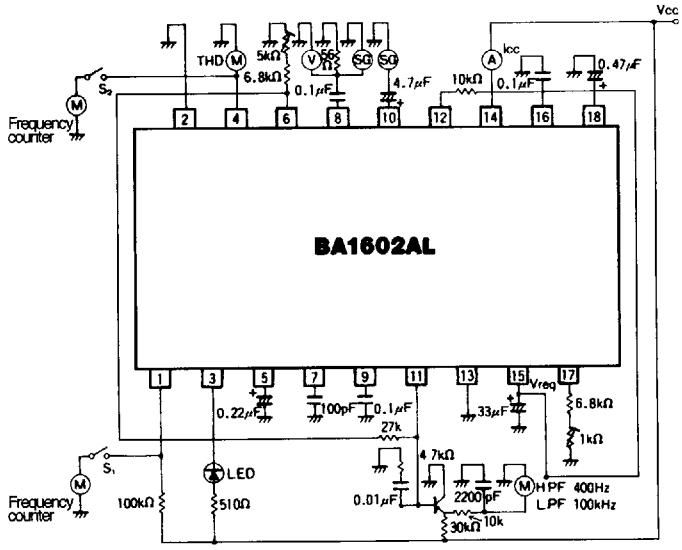
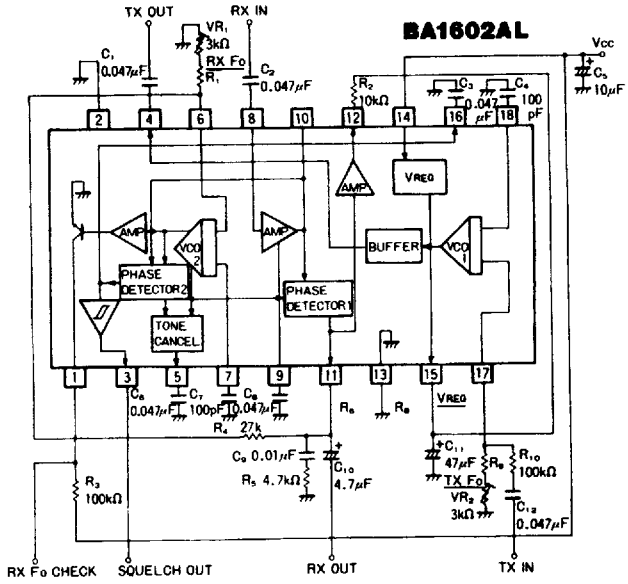
## Test circuit




## Application example



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## Application circuit operation

### Full duplex operation

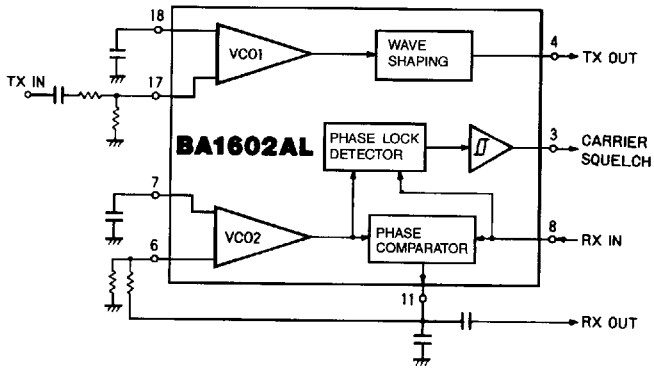
Full duplex operation can be accomplished using one BA1602AL as shown in Figure 1. A different frequency must be selected for transmit and receive. The following frequencies are available:

| | | | |
|---|---|---|---|
| A | 230 kHz | B | 270 kHz |
| C | 310 kHz | D | 350 kHz |
| E | 390 kHz | F | 430 kHz |

In the transmit section, frequency modulation is effected by superimposing the modulation signal on the VCO control voltage at pin 17. A wave-shaping circuit converts the transmit carrier to a pseudo-sinusoidal waveform to provide an output with a small harmonic content.

The receive section uses a PLL to demodulate the FM signal.

**Figure 1 Full duplex operation in a single BA1602AL**




### Full duplex with tone operation

A tone (usually less than 100 Hz) may be superimposed on a modulation signal to distinguish it from other signals. This makes the signal less susceptible to interference from, for instance, microwave ovens. Figure 2 shows a method of using two BA1602AL ICs to provide a full duplex intercom with tone.

This circuit is the same as the circuit of Figure 1, except that it has a second BA1602AL with a tone discriminator (squelch circuit) and a tone cancellation circuit added. The tone cancellation circuit removes the tone by adding a phase-inverted version of the tone to the demodulated signal.



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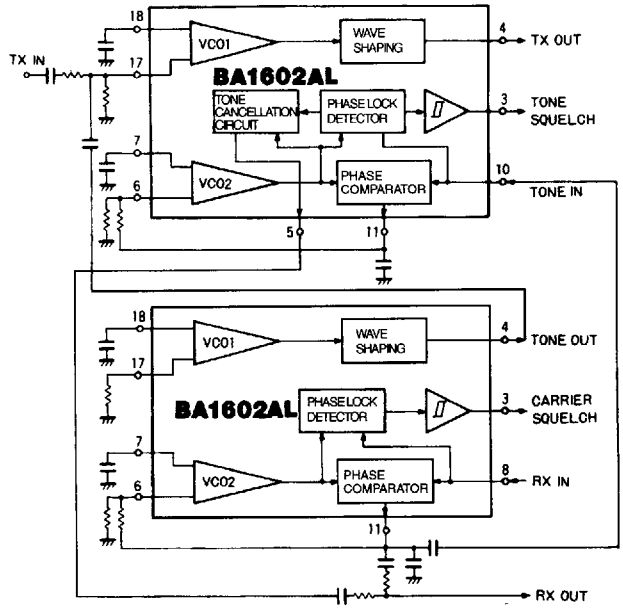
**Figure 2 Full duplex with tone operation in a double BA1602AL**




## Circuit description

**Voltage-controlled oscillators** (VCO1 and VCO2): The VCOs operate at a free-running frequency ($f_0$) that is determined by the external RC time constants as follows:

$f_0 = \frac{1}{2CR}$ where R is measured in ohms and C in farads

The values of R and C must be the same for both VCOs.

**Phase comparator** (Phase detector 1): The phase comparator uses a differential multiplier circuit. It demodulates the FM signal by comparing the phase of the incoming signal ($f_x$) with that of VCO2 ($f_0$), and outputting an error voltage that is a function of the phase difference.

**Phase lock detector** (Phase detector 2): This circuit determines whether the incoming signal ($f_x$) is phase-locked with the output of VCO2 ($f_0$). The circuit used is the same as that used for the phase comparator. It outputs a HIGH level when the signals are phase locked.

**Squelch circuit**: The squelch output is obtained by passing the phase detector output through a Schmitt trigger. The squelch output is HIGH when the incoming signal is weak or absent, and LOW when the incoming signal is strong. The squelch function can be used by feeding this output to an external transistor.

**Tone cancellation circuit**: The tone cancellation circuit can be used to suppress a tone superimposed on the received signal. The tone is canceled by adding a phase-inverted tone to the demodulated signal.



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## Electrical characteristic curves

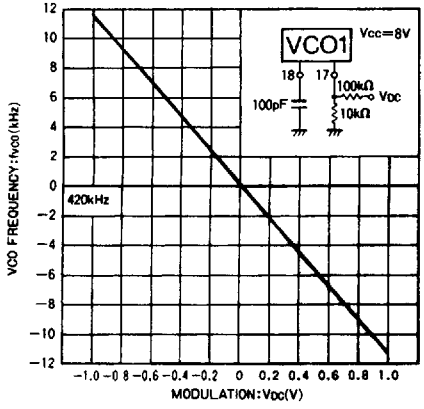


Figure 3

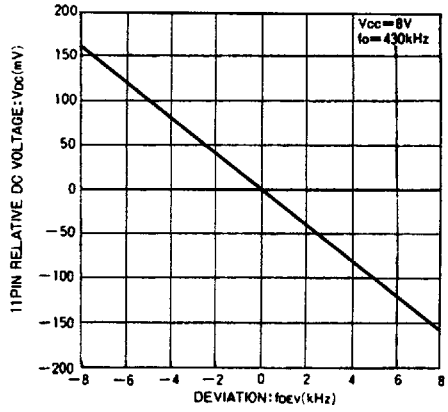


Figure 4

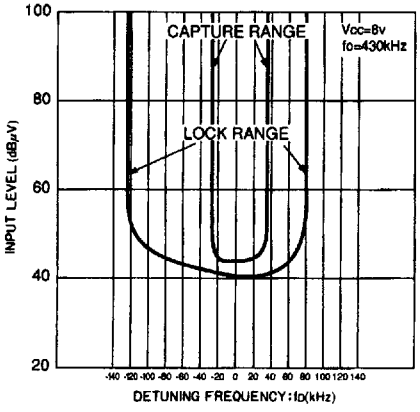


Figure 5

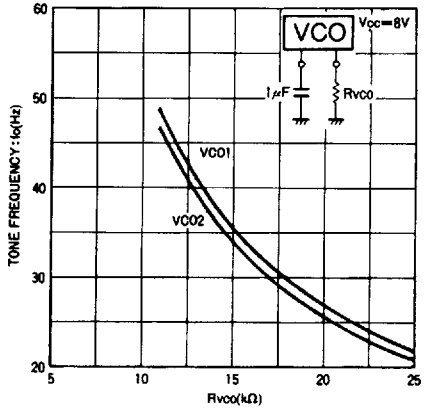


Figure 6

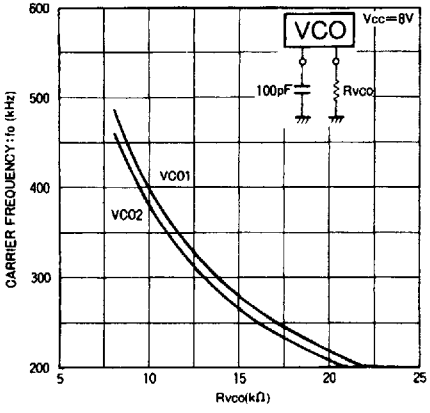


Figure 7

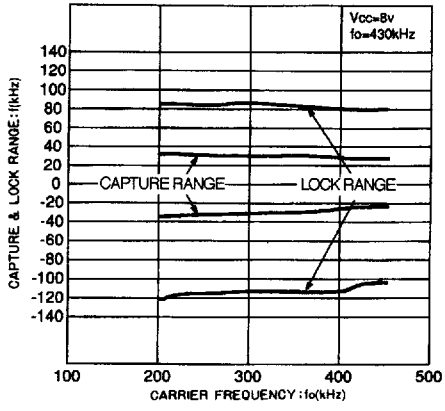


Figure 8



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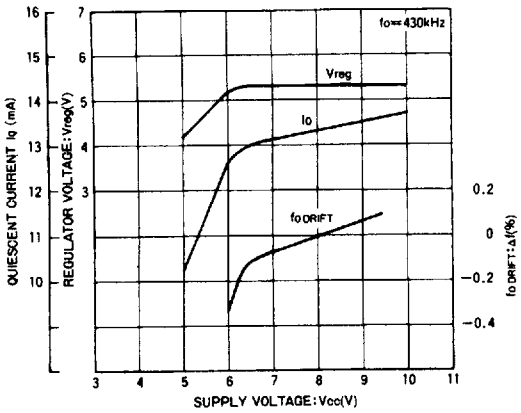


**Figure 9**

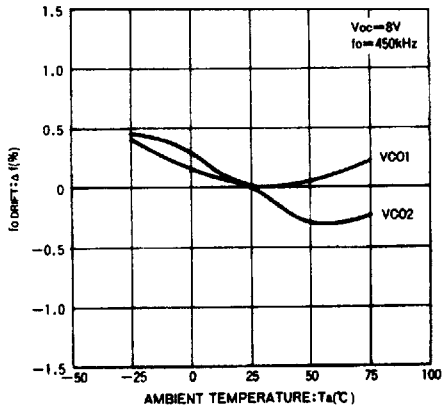


**Figure 10**



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