RS data

Tuned radio frequency receivers ZN414Z and ZN416E

Stock numbers 307-266 and 630-550

Two tuned radio frequency (TRF) circuits that provide a complete RF Amplifier, detector and AGC circuit on one chip.

The ZN414Z is a 10 transistor TRF circuit packaged in a 3 pin TO-92 case. The circuit requires six external components only to give a high quality AM tuner. Effective AGC action is available and is simply adjusted by selecting one external resistor value. Excellent audio quality can be achieved and current consumption is extremely low. No setting up or alignment is required and the circuit is completely stable in use.

The ZN414Z will drive a sensitive earpiece directly. In this case, an earpiece of equivalent impedance to R_{AGC} is substituted for R_{AGC} in the basic tuner circuit. Unfortunately, the cost of a sensitive earpiece is high, and unless an ultra-miniature radio is wanted, it is considerably cheaper to use a low cost crystal earpiece and add a single gain stage.

The ZN416E is a buffered output version of the ZN414Z in an 8 pin DIL package, giving typically 120mV (rms) output into a 64Ω load.

Features

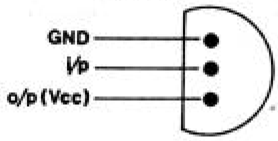
- Single cell operation (1.1 to 1.6V operating range)
- Low current consumption
- 150kHz to 3MHz frequency range (ie. full coverage of medium and long wavebands)
- Easy assembly, no alignment necessary
- Simple and effective AGC action
- Will drive crystal earphone direct (ZN414Z)
- Will drive headphones direct (ZN416E)
- Excellent audio quality
- Typical power gain of 72dB (ZN414Z)
- Minimum number of external components required.

Electrical characteristics $T_A = 25°C$, $V_{CC} = 1.4V$

Parameters apply to both devices unless otherwise stated.

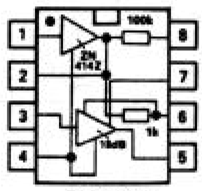
Parameter		Min.	Typ	Max.	Units
Supply voltage, V_{CC}		1.1	1.3	1.6	volts
Supply current, I_S	ZN414Z	–	0.3	0.5	mA
Supply current, I_S with 64Ω headphones	ZN416E	–	4	5	mA
Input frequency range		0.15	–	3.0	MHz
Input resistance		–	4.0	–	MΩ
Threshold sensitivity (Dependent on Q of coil)		–	50	–	μV
Selectivity		–	4.0	–	kHz
Total harmonic distortion		–	3.0	–	%
AGC range		–	20	–	dB
Power gain	ZN414Z	–	72	–	dB
Voltage gain of output stage	ZN416E	–	18	–	dB
Output voltage before clipping	ZN414Z	–	60	–	mVpp
Output voltage into 64Ω load before clipping	ZN416E	–	340	–	mVpp
Upper cut-off frequency of output stage, No capacitor	ZN416E	20	–	–	kHz
With 0.01μF between pin 7 and 0V	ZN416E	–	10	–	kHz
Lower cut-off frequency of output stage 0.47μF between pins 2 and 3	ZN416E	–	50	–	Hz
Quiescent output voltage	ZN414Z	–	40	–	mV
	ZN416E	–	200	–	mV
Operating temperature range		0	–	+70	°C
Maximum storage temperature		–65	–	+125	°C

ZN414Z



PIN VIEW

ZN416E



TOP VIEW

ZN414Z Characteristics

Figure 1 **Gain and AGC characteristics**

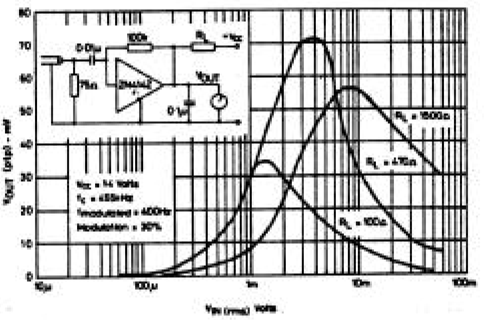
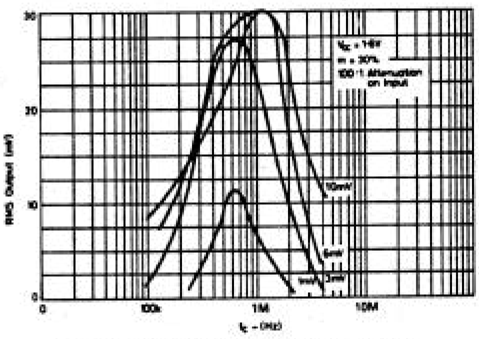


Figure 2 **Frequency response**



*Note that this graph represents the chip response, and not the receiver bandwidth.

Figure 3 **Gain variation with supply volts**

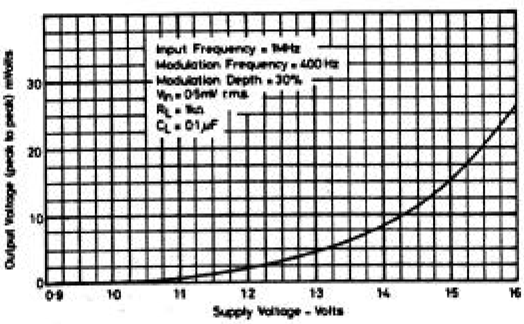
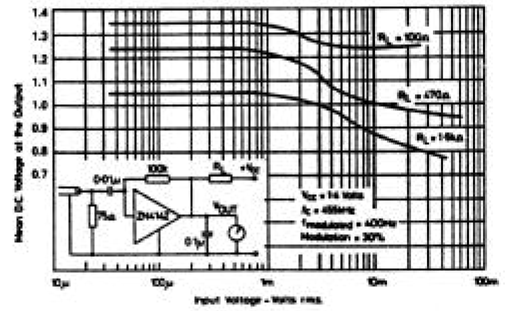


Figure 4 **DC level at output**



Layout requirements

As with any high gain RF device, certain basic layout rules must be adhered to if stable and reliable operation is to be obtained. These are listed below:

1. The output decoupling capacitor should be soldered as near as possible to the output and earth leads of the ZN414Z. Furthermore, its value together with the AGC resistor (R_{AGC}) should be calculated at ≈ 4kHz, ie.:

$$C\ (\text{farads}) = \frac{1}{2\pi \times R_{AGC} \times 4 \times 10^3}$$

2. All leads should be kept as short as possible, especially those in close proximity to the ZN414Z.
3. The tuning assembly should be some distance from the battery, loudspeaker and their associated leads.
4. The 'earthy' side of the tuning capacitor should be connected to the junction of the 100kΩ resistor and the 0.01µF capacitor.

Operating notes

Selectivity

To obtain good selectivity, essential with any TRF device, the ZN414Z must be fed from an efficient, high 'Q' coil and capacitor tuning network. With suitable components the selectivity is comparable to superhet designs, except that a very strong signal in proximity to the receiver may swamp the device unless the ferrite rod aerial is rotated to 'null-out' the strong signal.

Gain (AGC)

To obtain optimum results using the ZN414Z it is important that the AGC mechanism is understood. Signal strength, ferrite rod size and the 'Q' of the coil all affect the signal ultimately presented to the AGC network. To compensate for these variables, the gain of the chip is variable, by varying the supply voltage (see Figure 3). With the gain set too high, the AGC circuit will swamp, causing strong stations to appear to occupy large bandwidths. The effect is similar to poor selectivity, except that in extreme cases distortions may also occur. If the gain is set too low, the signal-to-noise ratio worsens. A compromise between the two extremes is needed, and whilst the circuits given in this data sheet work adequately under most operating conditions, the experimenter may well like to note the effect of varying the supply voltage to the ZN414Z with a view to optimising for his individual requirements.

The value of the AGC resistor may be varied; for most applications 1.5kΩ represents the optimum value. For some earpiece circuits, where the operating requirements are somewhat different, 680Ω gives better results. If the value of the resistor is altered, note that the supply current for the ZN414Z flows through it (typically 0.3mA), and the supply voltage will also have to be changed.

$V_{ZN414} = V_{supply} - 0.3\ R_{AGC}$ where R_{AGC} is in kilohms.

The voltage, and hence gain, of the ZN414Z can be increased until instability results. A further gain increase, at the expense of audio quality, can be achieved by increasing the capacitor across the output and earth terminals from 0.22μF up to a maximum of 0.82μF.

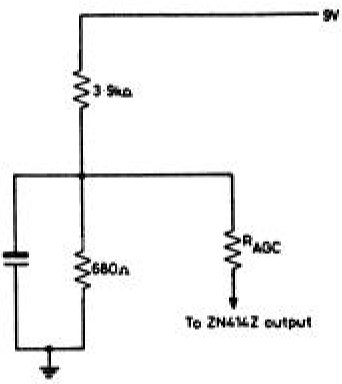
Ferrite aerial size

Because of the gain variation available by altering supply voltage, the size of the ferrite rod is relatively unimportant. However, the ratio of aerial rod length to diameter should ideally be large to give the receiver better directional properties. Successful receivers have been constructed with ferrite rod aerials of 4cm (1.5in) and up to 20cm (8in).

Drive circuits ZN414Z

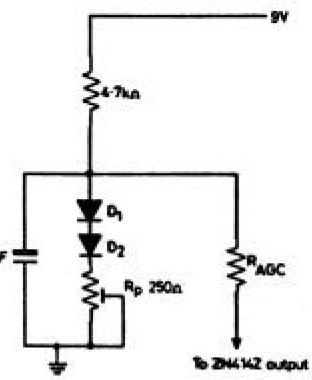
Three types of drive circuit are shown, each has been used successfully. The choice is largely an economic one, but Figure 7 is recommended wherever possible, having several advantages over the other circuits. Values for 9V supplies are shown, simple calculations will give values for other supplies.

Figure 5 **Resistive divider**



Note: Replacing the 680Ω resistor with a 500Ω resistor and a 250Ω preset, sensitivity may be adjusted and will enable optimum reception to be realised under most conditions.

Figure 6 **Diode drive**

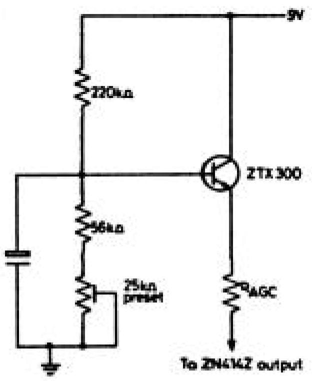


$D_1 = D_2$ = Any general purpose silicon diode

R_p = Optional sensitivity control, a recommended value being 250Ω.

Current consumption ≈ 1.5mA

Figure 7 **Transistor drive**



Current consumption is virtually that which is taken by the ZN414Z (0.3mA)

Applications information

Figure 8 **ZN414Z**

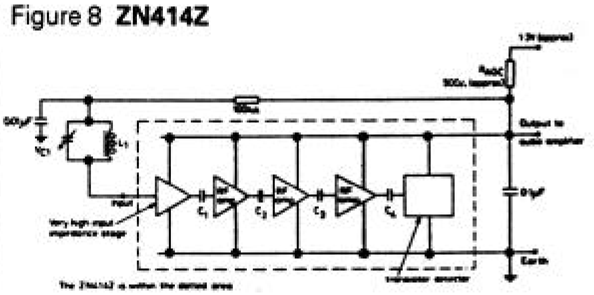


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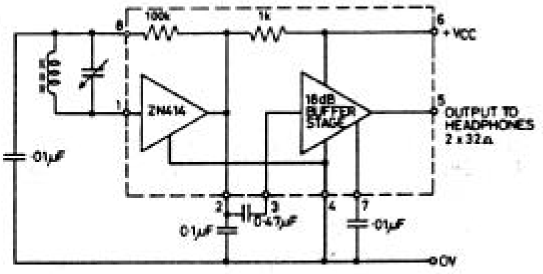
Figure 9 **ZN416E**



THE ZN416E IS WITHIN THE DOTTED AREA