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TECHNICAL DATA

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XR-2206 Monolithic Function Generator

Description

The XR-2206 is a monolithic function generator integrated circuit capable of producing high quality sine, square, triangle, ramp and pulse waveforms of high stability and accuracy. The output waveforms can be both amplitude and frequency modulated by an external voltage. Frequency of operation can be selected externally over a range of 0.01 Hz to more than 1 MHz.

The XR-2206 is ideally suited for communications, instrumentation, and function generator applications requiring sinusoidal tone, AM, FM or FSK generation. It has a typical drift specification of 20 ppm/°C. The oscillator frequency can be linearly swept over a 2000:1 frequency range with an external control voltage with very little affect on distortion.

As shown in Figure 1, the monolithic circuit is comprised of four functional blocks: a voltage-controlled oscillator (VCO); an analog multiplier and sine-shaper; a unity gain buffer amplifier; and a set of current switches. The internal current switches transfer the oscillator current to any one of the two external timing resistors to produce two discrete frequencies selected by the logic level at the FSK input terminal (pin 9).

Features

- Low Sinewave Distortion (THD .5%), insensitive to signal sweep
- Excellent Stability (20 ppm/°C, typ)
- Wide Sweep Range (2000:1, typ)
- Low Supply Sensitivity (0.01%/V, typ)
- Linear Amplitude Modulation
- Adjustable Duty-Cycle (1% to 99%)
- TTL Compatible FSK Controls
- Wide Supply Range (10V to 26V)

Applications

- Waveform Generation
  Sine, Square, Triangle, Ramp
- Sweep Generation
- AM/FM Generation
- FSK and PSK Generation
- Voltage-to-Frequency Conversion
- Tone Generation
- Phase-Locked Loops

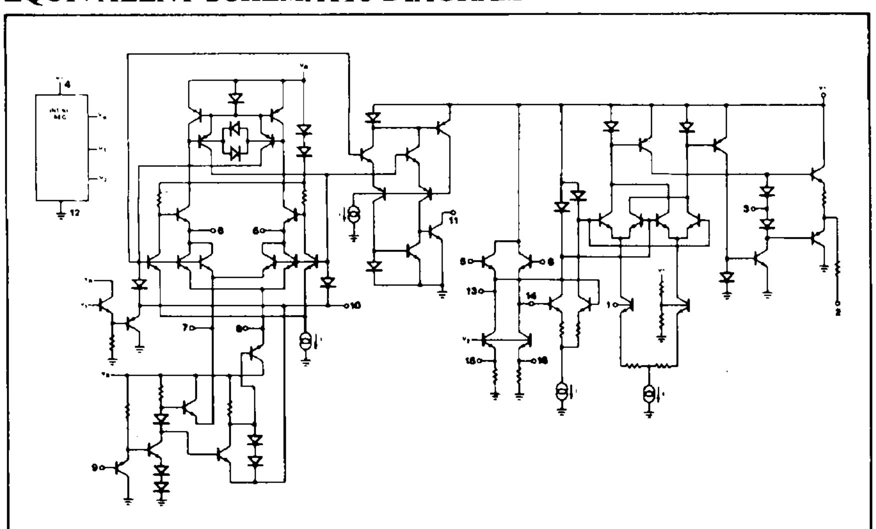
Absolute Maximum Ratings

Power Supply	**26V**
Power Dissipation	**625mW**
Derate above +25°C	**5 mW/°C**
Storage Temperature Range	**−65°C to +150°C**
Operating Temperature Range	**0°C to +75°C**

EQUIVALENT SCHEMATIC DIAGRAM

FUNCTIONAL BLOCK DIAGRAM

EQUIVALENT SCHEMATIC DIAGRAM



FUNCTIONAL BLOCK DIAGRAM

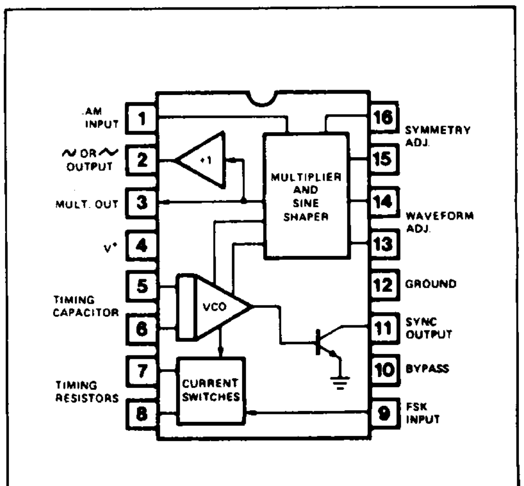


Figure 1.

ELECTRICAL CHARACTERISTICS

Test Conditions: Test Circuit of Fig. 2, $V^+ = 12V$, $T_A = 25°C$, $C = 0.01\ \mu F$, $R_1 = 100\ K\Omega$, $R_2 = 10\ K\Omega$ $R_3 = 25\ K\Omega$ unless otherwise specified. S_1 open for triangle, closed for sinewave.

CHARACTERISTICS	MIN.	TYP.	MAX.	UNITS	CONDITIONS
Supply Voltage					
Single Supply	10		26	V	
Split Supply	±5		±13	V	
Supply Current		14	20	mA	$R_1 \geq 10\ K\Omega$
Oscillator Section					
Max. Operating Frequency	0.5	1		MHz	C = 1000 pF, $R_1 = 1\ K\Omega$
Lowest Practical Frequency		0.01		Hz	$C = 50\ \mu F$, $R_1 = 2\ M\Omega$
Frequency Accuracy		±2		% of f_0	$f_0 = 1/R_1C$
Temperature Stability		±20		ppm/°C	$0° C \leq T_A \leq 75°C$, $R_1 = R_2 = 20\ K\Omega$
Supply Sensitivity		0.01		%/V	$V_{LOW} = 10V$, $V_{HIGH} = 20V$, $R_1 = R_2 = 20\ K\Omega$
Sweep Range		2000:1		$f_H = f_L$	f_H@R = 1 KΩ, f_L@R_1 = 2 MΩ
Sweep Linearity					
10:1 Sweep		2		%	f_L = 1 kHz, f_H = 10 kHz
1000:1 Sweep		8		%	f_L = 100 Hz, f_H = 100 kHz
FM Distortion		0.1		%	±10% Deviation
Recommended Timing Components					
Timing Capacitor: C	0.001		100	μF	See Figure 5
Timing Resistors: R_1 & R_2	1		2000	KΩ	
Triangle/Sinewave Output					See Note 1, Fig.3
Triangle Amplitude		160		mV/KΩ	Fig. 2 S_1 Open
Sinewave Amplitude		60		m/VKΩ	Fig. 2 S_1 Closed
Max. Output Swing		6		Vpp	
Output Impedance		600		Ω	
Triangle Linearity		1		%	
Amplitude Stability		0.5		dB	For 1000:1 Sweep
Sinewave Amplitude Stability		−4800		ppm/°C	See Note 2
Sinewave Distortion					$R_1 = 30\ K\Omega$
Without Adjustment		2.5		%	See Figure 8
With Adjustment		0.5	1.5	%	See Figure 9
Amplitude Modulation					
Input Impedance	50	100		KΩ	
Modulation Range		100		%	
Carrier Suppression		55		dB	
Linearity		2		%	For 95% modulation
Square Wave Output					Measured at Pin 11
Amplitude		12		Vpp	
Rise Time		250		nsec	C_L=10 pF
Fall Time		50		nsec	C_L=10 pF
Saturation Voltage		0.2	0.6	V	I_L=2 mA
Leakage Current		0.1	100	μA	V_{11}=26 V
FSK Keying Level (Pin 9)	0.8	1.4	2.4	V	See Section on Circuit Controls
Reference Bypass Voltage	2.5	3	3.5	V	Measured at Pin 10.

Note 1: Output Amplitude is directly proportional to the resistance R_3 on Pin 3. See Figure 3.
Note 2: For maximum amplitude stability R_3 should be a positive temperature coefficient resistor.

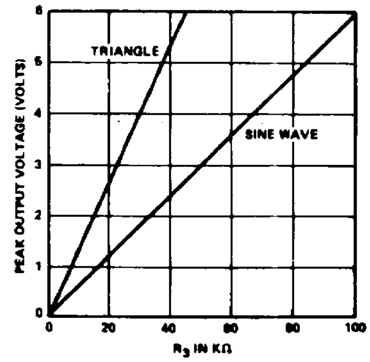


Figure 3. Output Amplitude as a Function of Resistor R_3 at Pin 3.

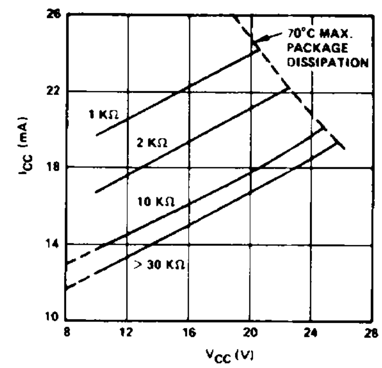


Figure 4. Supply Current vs Supply Voltage, Timing R

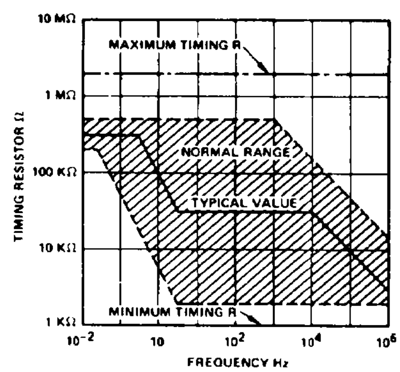


Figure 5. R vs Oscillation Frequency

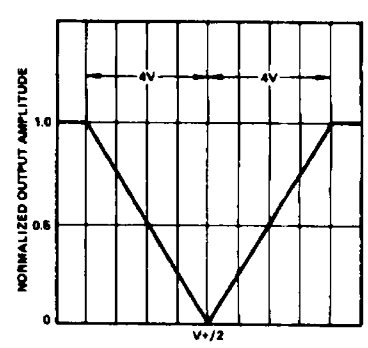


Figure 6. Normalized Output Amplitude vs DC Bias at AM Input (Pin 1).

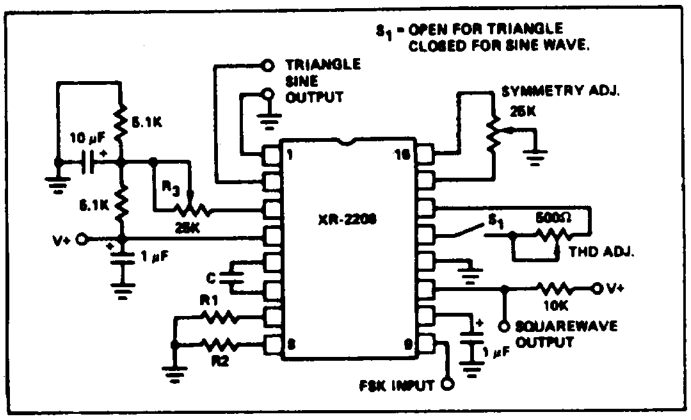


Figure 2. Basic Test Circuit

DESCRIPTION OF CIRCUIT CONTROLS

Frequency of Operation:

The frequency of oscillation, f_0, is determined by the external timing capacitor C across pins 5 and 6, and by the timing resistor R connected to either pin 7 or pin 8. The frequency is given as

$$f_0 = \frac{1}{RC} \text{ Hz}$$

and can be adjusted by varying either R or C. The recommended values of R for a given frequency range are shown in Figure 5. Temperature-stability is optimum for 4 KΩ < R < 200 KΩ. Recommended values of C are from1000 pF to 100 µF.

Frequency Sweep And Modulation

Frequency of oscillation is proportional to the *total* timing current I_T drawn from pin 7 or 8

$$f = \frac{320 I_T \text{ (mA)}}{C\ (\mu F)} \quad \text{Hz}$$

Timing terminals (pins 7 or 8) are low impedance points and are internally biased at +3V, with respect to pin 12. Frequency varies linearly with I_T over a wide range of current values, from 1 µA to 3 mA. The frequency can be controlled by applying a control voltage, V_C, to the activated timing pin as shown in Figure 7. The frequency of oscillation is related to V_C as:

$$f = \frac{1}{RC}\left[1 + \frac{R}{R_C}\left(1 - \frac{V_C}{3}\right)\right] \text{ Hz}$$

where V_C is in volts. The voltage-to-frequency conversion gain, K, is given as:

$$K = \partial f/\partial V_C = -\frac{0.32}{R_C C} \quad \text{Hz/V}$$

NOTE: For safe operation of the circuit I_T should be limited to ≤3 mA.

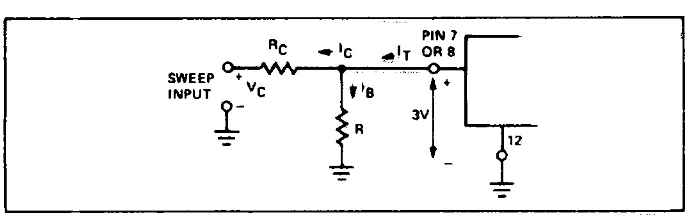


Figure 7: Circuit Connection for Frequency Sweep

Output Characteristics:

Output Amplitude: Maximum output amplitude is directly proportional to external resistor R_3 connected to Pin 3 (See Fig. 3). For sinewave output, amplitude is approximately 60mV peak per KΩ of R_3; for triangle, the peak amplitude is approximately 160 mV peak per KΩ of R_3. Thus, for example, R_3 = 50 KΩ would produce approximately ±3V sinusoidal output amplitude.

Amplitude Modulation: Output amplitude can be modulated by applying a dc bias and a modulating signal to Pin 1. The internal impedance at Pin 1 is approximately 100 KΩ. Output amplitude varies linearly with the applied voltage at Pin 1, for values of dc bias at this pin, within ±4 volts of $V^+/2$ as shown in Fig. 6. As this bias level approaches $V^+/2$, the phase of the output signal is reversed; and the amplitude goes through zero. This property is suitable for phase-shift keying and suppressed-carrier AM generation. Total dynamic range of amplitude modulation is approximately 55 dB.

Note: AM control must be used in conjunction with a well-regulated supply since the output amplitude now becomes a function of V^+

Frequency-Shift Keying

The XR-2206 can be operated with two separate timing resistors, R_1 and R_2, connected to the timing pins 7 and 8, respectively, as shown in Figure 13. Depending on the polarity of the logic signal at pin 9, either one or the other of these timing resistors is activated. If pin 9 is open-circuited or connected to a bias voltage ≤ 2V, only R_1 is active. Similarly, if the voltage level at pin 9 is ≤ 1V, only R_2 is activated. Thus, the output frequency can be keyed between two levels, f_1 and f_2 as:

$$f_1 = 1/R_1C \text{ and } f_2 = 1/R_2C$$

For split-supply operation, the keying voltage at pin 9 is referenced to V^-.

Output DC Level Control

The dc level at the output (pin 2) is approximately the same as the dc bias at pin 3. In Figures 8, 9 and 10, pin 3 is biased mid-way between V^+ and ground, to give an output dc level of ≈ $V^+/2$.

APPLICATIONS INFORMATION

Sinewave Generation

A) Without External Adjustment

Figure 8 shows the circuit connection for generating a sinusoidal output from the XR-2206. The potentiometer R_1 at pin 7 provides the desired frequency tuning. The maximum output swing is greater than $V^+/2$ and the typical distortion (THD) is < 2.5%. If lower sinewave distortion is desired, additional adjustments can be provided as described in the following section.

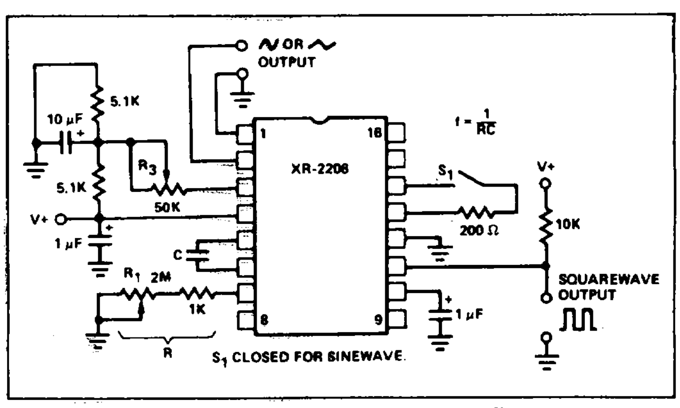


Figure 8: Circuit for Sinewave Generation Without External Adjustment. (See Fig. 3 for choice of R_3)

The circuit of Figure 8 can be converted to split supply operation simply by replacing all ground connections with V−. For split supply operation, R_3 can be directly connected to ground.

B) With External Adjustment

The harmonic content of sinusoidal output can be reduced to ≈0.5% by additional adjustments as shown in Figure 9. The potentiometer R_A adjusts the sine-shaping resisitor; and R_B provides the fine-adjustment for the waveform symmetry. The adjustment procedure is as follows:

1. Set R_B at mid-point and adjust R_A for minimum distortion.
2. With R_A set as above, adjust R_B to further reduce distortion.

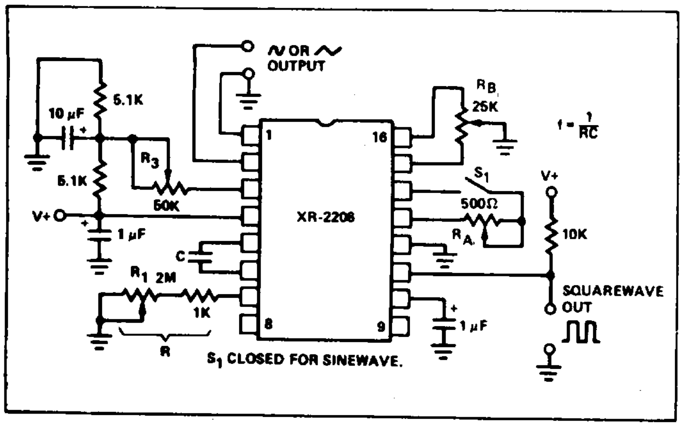


Figure 9: Circuit for Sinewave Generation With Minimum Harmonic Distortion. (R_3 Determines output Swing – See Fig. 3)

Triangle Wave Generation

The circuits of Figures 8 and 9 can be converted to triangle wave generation by simply open circuiting pins 13 and 14 (i.e., S_1 open). Amplitude of the triangle is approximately twice the sinewave output.

FSK Generation

Figure 10 shows the circuit connection for sinusoidal FSK signal generation. Mark and space frequencies can be independently adjusted by the choice of timing resistors R_1 and R_2; and the output is phase-continuous during transitions. The keying signal is applied to pin 9. The circuit can be converted to split-supply operation by simply replacing ground with V−.

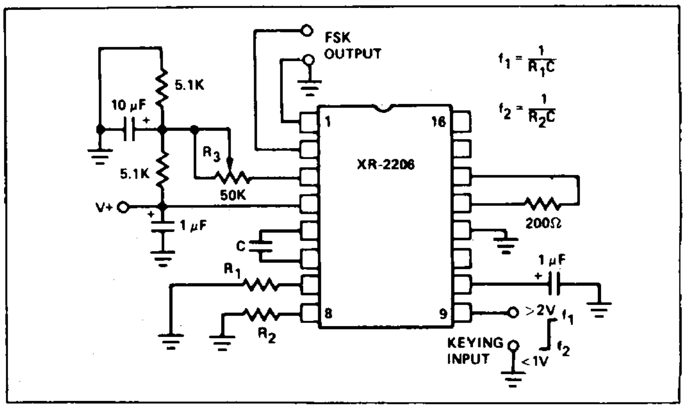


Figure 10: Sinusoidal FSK Generator

Pulse And Ramp Generation

Figure 11 shows the circuit for pulse and ramp waveform generation. In this mode of operation, the FSK keying terminal (pin 9) is shorted to the square-wave output (pin 11); and the circuit automatically frequency-shift keys itself between two separate frequencies during the positive and negative going output waveforms. The pulse-width and the duty cycle can be adjusted from 1% to 99% by the choice of R_1 and R_2. The values of R_1 and R_2 should be in the range of 1 KΩ to 2 MΩ.

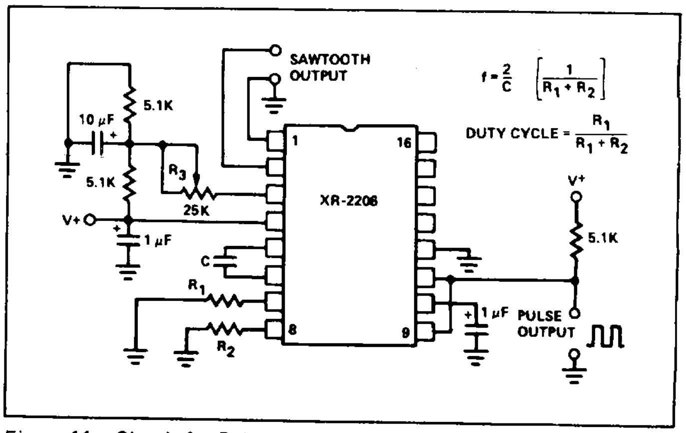


Figure 11: Circuit for Pulse and Ramp Generation

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