APPENDIX – D

P

12·6·2. Type 205 Function Generator

The XR-205 is a highly versatile, monolithic waveform generator designed for diverse applications in communication and telemetry equipment, as well as in system design and testing. It is a self-contained, totally monolithic signal generator that provides sine, square, triangle, ramp and sawtooth output waveforms, which can be both amplitude and frequency modulated.

Fig. 12·40 shows the functional block diagram of the monolithic waveform generator. The circuit has three separate sections : (*i*) Voltage controlled oscillator (VCO) (*ii*) Balanced modulator and (*iii*) Buffer Amplifier. The VCO generates the basic periodic waveforms. The balaced modulator provides amplitude or phase

modulation. The buffer amplifier is used to provide a low impedance output and high current drive capability.

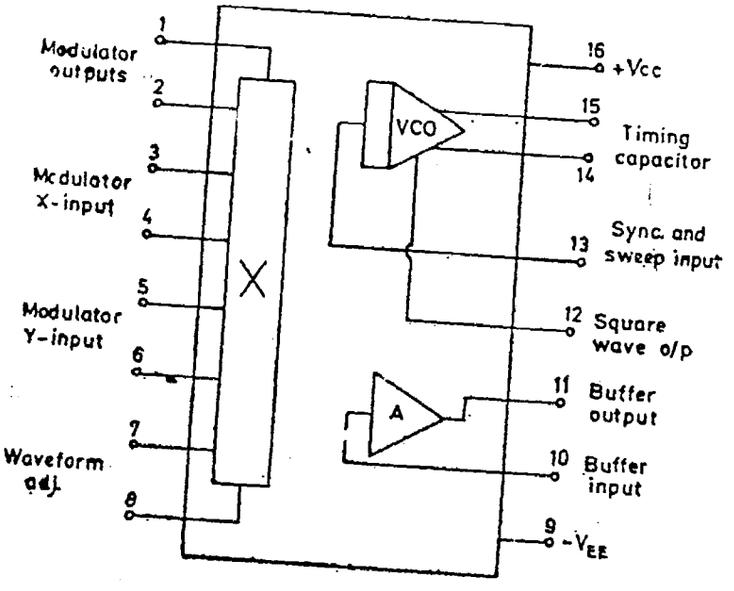


Fig. 12·40. Block diagram of type 205 waveform generator.

Fig. 12·41 shows a practical connection diagram of XR-205 which is used to generate various waveform. The device is operated with a single supply.

A timing capacitor C_o is connected across terminals 14 and 15. With the sweep input terminal open circuited, VCO produces a frequency $f_o \simeq 400/C_o$, where f_o is in Hz C_o is in micro farads. By varying C_o, the frequency of VCO can be varied in inverse proportion. Pins 5 and 6, which are modulator y-inputs are directly connected to pins 15 and 14 respectively. These connections are required to produce sine or triangular wave output. Pins 1 and 2 provide modulator output which is proportional to a d.c. voltage applied across the modulator X-input terminals (pins 3 and 4). These inputs can be used for amplitude modulation or, as an output amplitude control. In Fig. 12·41, pins 3 and 4 are connected for output amplitude control. The phase of the output voltage can be reversed by reversing the polarity of the d.c. bias across pins 3 and 4. Such phase reversing is useful for phase shift keying (PSK). Terminals 1 and 2 are provided as modulator output. All of the high level output waveforms are obtained at these terminals.

A 15 KΩ load resistor is connected across pins 1 and 2 to prevent the output from saturating or clipping at large output swings.

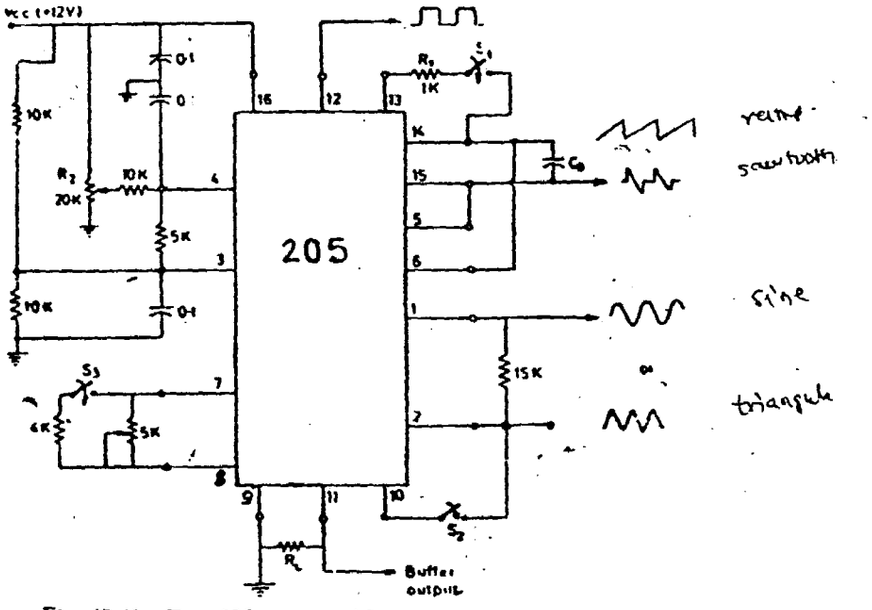


Fig. 12·41. Type 205 connected for single supply operation to generate various waveforms.

At pin 12, low level square wave output is directly available. It provides symmetrical square wave with 0·7 volt amplitude and 20 ns rise time. However, by using the modulator section as an amplifier, the square wave output level can be raised to a level of 3 volts peak-to-peak.

A sweep voltage applied at terminal 13 (which is also used for FM input) changes the VCO frequency. This frequency increases linearly with an increasing negative voltage. Normally a series resistor of 1 kΩ is connected in series with this terminal to provide current limiting and linear voltage-to-frequency conversion. The frequency of oscillation can also be synchronised to an external source by applying a synchonised pulse to this terminal.

The shape of the output waveform at pins 1 and 2 is controlled by a potentiometer connected between pins 7 and 8. The potentiometer normally connected for this purpose is of 5 kΩ. For sinewave outputs at pins 1 and 2, the value of the potentiometer is adjusted to minimise the harmonic content of the output waveform. This adjustment is independent of frequency and needs to

be done only once. The output can be converted to a symmetrical triangle waveform by increasing the effective resistance across these terminals. This can be done without changing the potentiometer setting, by opening the switch S_1 as shown in Fig. 12·41.

The buffer amplifier shown in Fig. 12·40 can be connected to any of the circuit outputs, *i.e.* pins 1, 2, 12, 14 or 15, to provide low output impedance and high current drive capability. For proper operation of the buffer amplifier pin 11 must be connected to the most negative potential in the circuit, with an external load resistor R_L (0·75 KΩ$<R_L<$10 KΩ). The maximum output current at this pin must not exceed 20 mA.

The duty cycle of the output waveforms can be adjusted by connecting a variable resistor across pins 13 and 14. With switch S_1 open, the output waveform will be symmetrical. In the following paragraphs, we describe the circuit connections necessary to generate the output waveforms.

For sinewave output, the switch S_1 is kept open and S_2 is closed. The sinewave available at pins 7 and 8 is adjusted for minimum harmonic distortion using trimmer resistor connected across the pins. If buffer amplifier is used to avoid loading, the sine wave will be available at pin 11. The amplitude of the output waveform is controlled by the differential d.c. voltage appearing between pins 3 and 4. This bias can be controlled by potentiometer R_2. For a differential bias between these terminals of ±2 volts or greater, the output amplitude is maximum and equal to approximately 3 volts peak-to-peak. For triangular wave switch S_1 and S_2 are open and the circuit is connected as shown in Fig. 12·41.

For sawtooth output the circuit connections are same as in Fig. 12·41 but switch S_1 is kept open and S_2 is closed. Closing S_1 places resistor (1 K) across pins 13 and 14. This changes the duty cycle of the triangle output and converts it to a sawtooth waveform The polarity of the sawtooth can be changed be reversing the polarity of the d.c. bias across pins 3 and 4. If S_3 is closed, the linear sawtooth waveform becomes converted to sinusoidal sawtooth waveform.

For ramp output, switch S_3 of Fig. 12·41 is opened and pin 10 is shorted at pin 14. This results in a 1·4 volts *p-p* ramp output at pin 11. The duty cycle of this ramp can be controlled by connecting a resistor across pins 13-14 or 13-15.

For squarewave output and pulse outputs the circuit is connected as shown in Fig. 12·42. For square wave, S_1 is kept open. The output can be converted to a pulse by closing S_1. The duty cycle of the pulse output is controlled by potentiometer R_D. The amplitude and polarity of either the pulse or square wave output can be controlled by potentiometer R_1. Note that to

get square and pulse output of 3 volts (*p-p*) dual (positive-negative) power supply of ±6 volts is necessary.

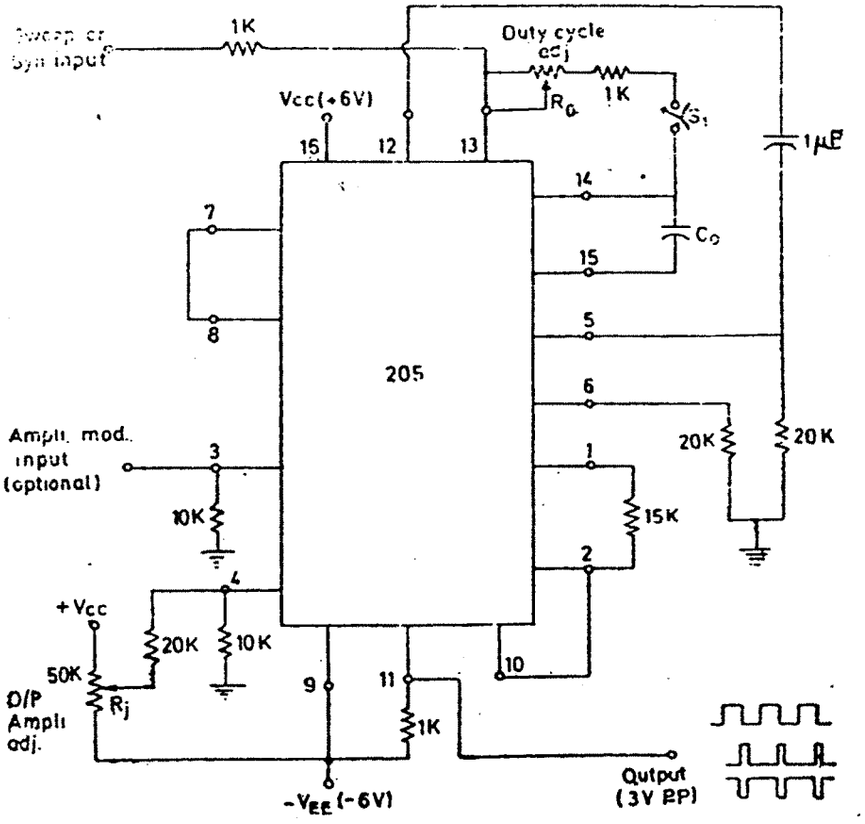


Fig. 12·42. Type 205 connected for square wave and pulse output.

The electrical characteristics of XR-205 are given in the Appendix.

REFERENCES

Coughlin, R.F. and F.E. Driscoll, *Operational Amplifiers and Linear Integrated Circuits*, Prentice-Hall, Second edition, Englewood cliffs, NJ, 1982.

Exar, *Applications Data Book* latest edition.

National Semiconductor, *Linear Application Handbook*, latest edition.

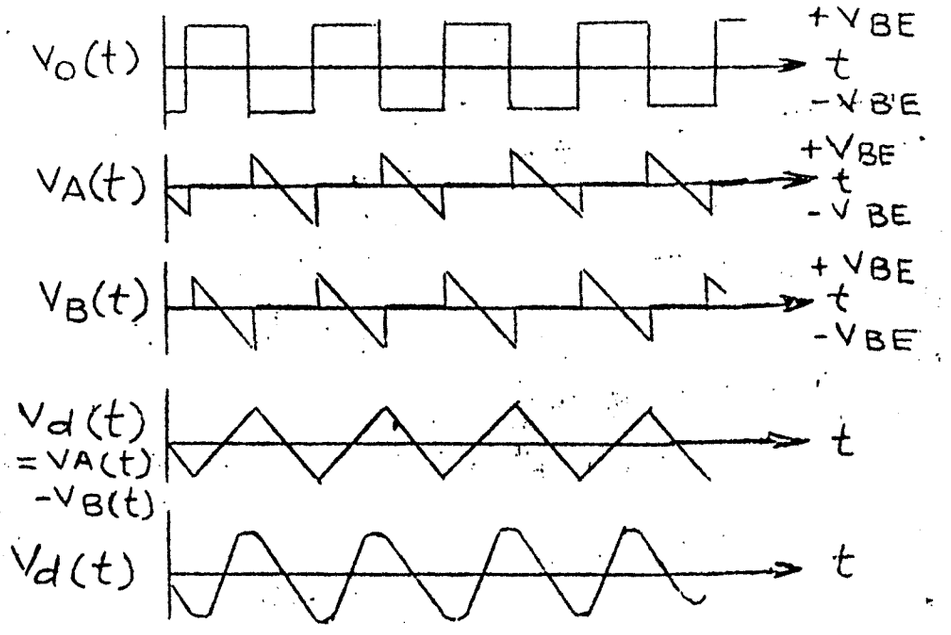


FIG. 3.3 – WAVEFORMS AT VARIOUS TERMINALS OF XR-205.

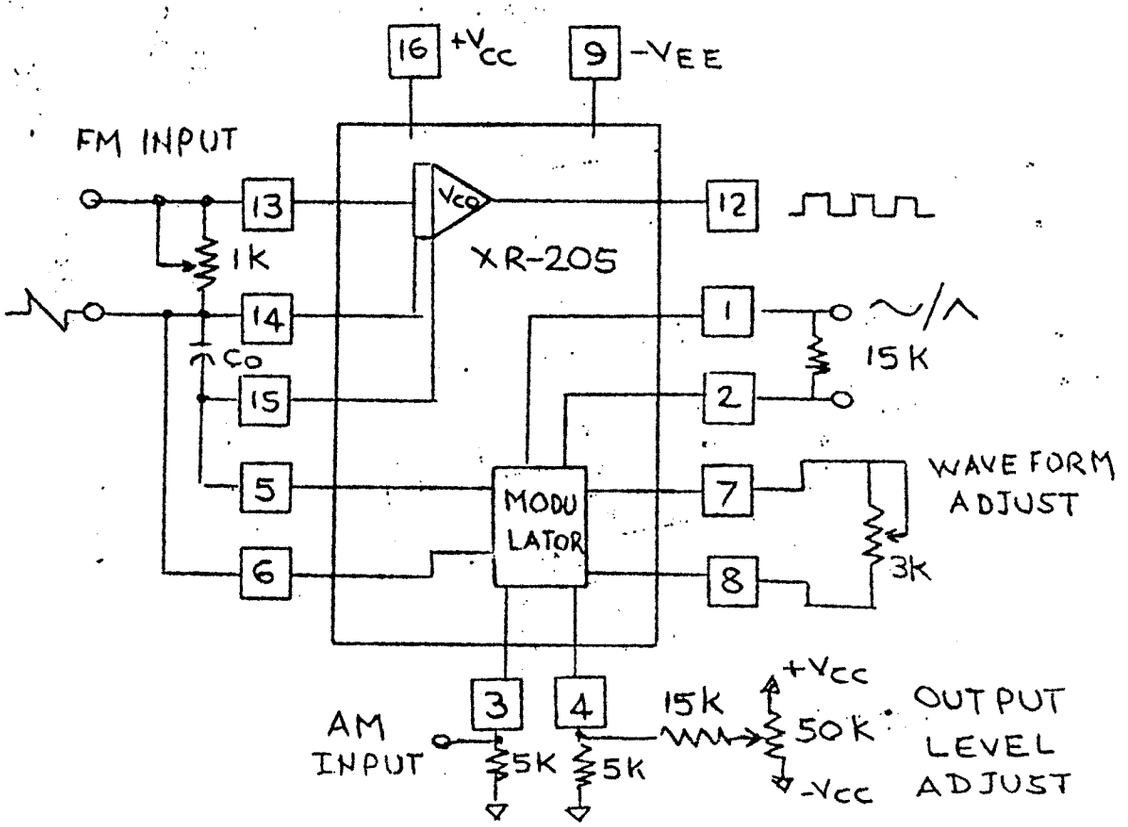


FIG. 3.4 – CONN[illegible] DIAGRAM OF XR-205.

3.5 Application of IC Function Generators :

The major use of IC function generators abounds in generating sine, tri ngle, square, sawtooth, ramp and pulse

Specifications of XR-205	Specifications of i 8038
Frequency Range : Sine and Square wave, 0.1 HZ-5 MHZ. Triangle and Ramp, 0.1 HZ-500 KHZ Frequency Stability : Temperature, 300 ppm/°C Power supply, 0.2%/volt Frequency Sweep Range : 10 to 1 FM(non) Linearity :>0.5% Triangle, ramps, (and) sawtooth linearity : 1% for fo < 200 KHz Sinusoidal THD : < 2.5% Squarewave duty cycle adjust range : 20% to 80% Modulation capability : AM, FM, FSK, PSK, Tone burst	Frequency Range : All waveforms, 1 mHZ-1 MHZ Frequency Stability : Temperature, 50 ppm/°C Power supply, 0.05% /volt Frequency Sweep range: 1000 to 1 FM(non) linearity : 0.2% Triangle, ramp and sawtooth Linearity : 0.1% Sinusoidal THD : 0.8%(typ) Square wave duty cycle adjust range : 2% to 98% Modulation capability : FM

Monolithic Waveform Generator
(Type XR 205)

Important Ratings :

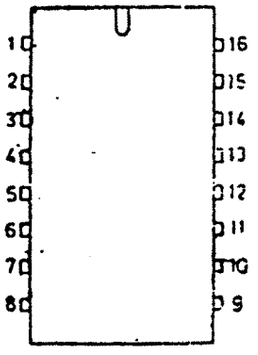
Supply voltage	26 V (max.)
Power dissipation	750 mW (max.)

Typical values of parameters at $T=25°C$, $f=1$ KHz, supply voltage $=12$ V, $R_L=3$ KΩ unless otherwise specified.

Supply voltage (single supply)	8 to 26 V
Supply current	10 mA (w/o buffer Amp.)
Frequency sweep range	10 : 1
Output swing single ended	$3\ V_{p-p}$
Differential	$6\ V_{p-p}$
Amplitude control range	60 dB
Output current swing	±10 mA ($p-p$)
Sinusoidal output waveform	
Upper frequency limit	4 MHz
Triangular output waveform	
Non-linearity	±1%
Ramp output waveform	
Non-linearity	1·5%
Sawtooth output waveform	
Non-linearity	1%
Square wave output duty cycle asymmetry	+1%
Pulse output waveform duty cycle range	20–80%

Pin Connection Diagram

TOP VIEW



1. Modulator O/P
2. Modulator O/P
3. Modulator X input
4. Modulator X input
5. Modulator Y input
6. Modulator Y input
7. Waveform adjust
8. Waveform adjust
9. $-V_{EE}$
10. Buffer input
11. Buffer output
12. Square wave O/P
13. FM Sync. and Sweep input
14. Timing capacitor
15. Timing capacitor
16. $+V_{CC}$