



VOLTAGE CONTROLLED OSCILLATOR

DESCRIPTION

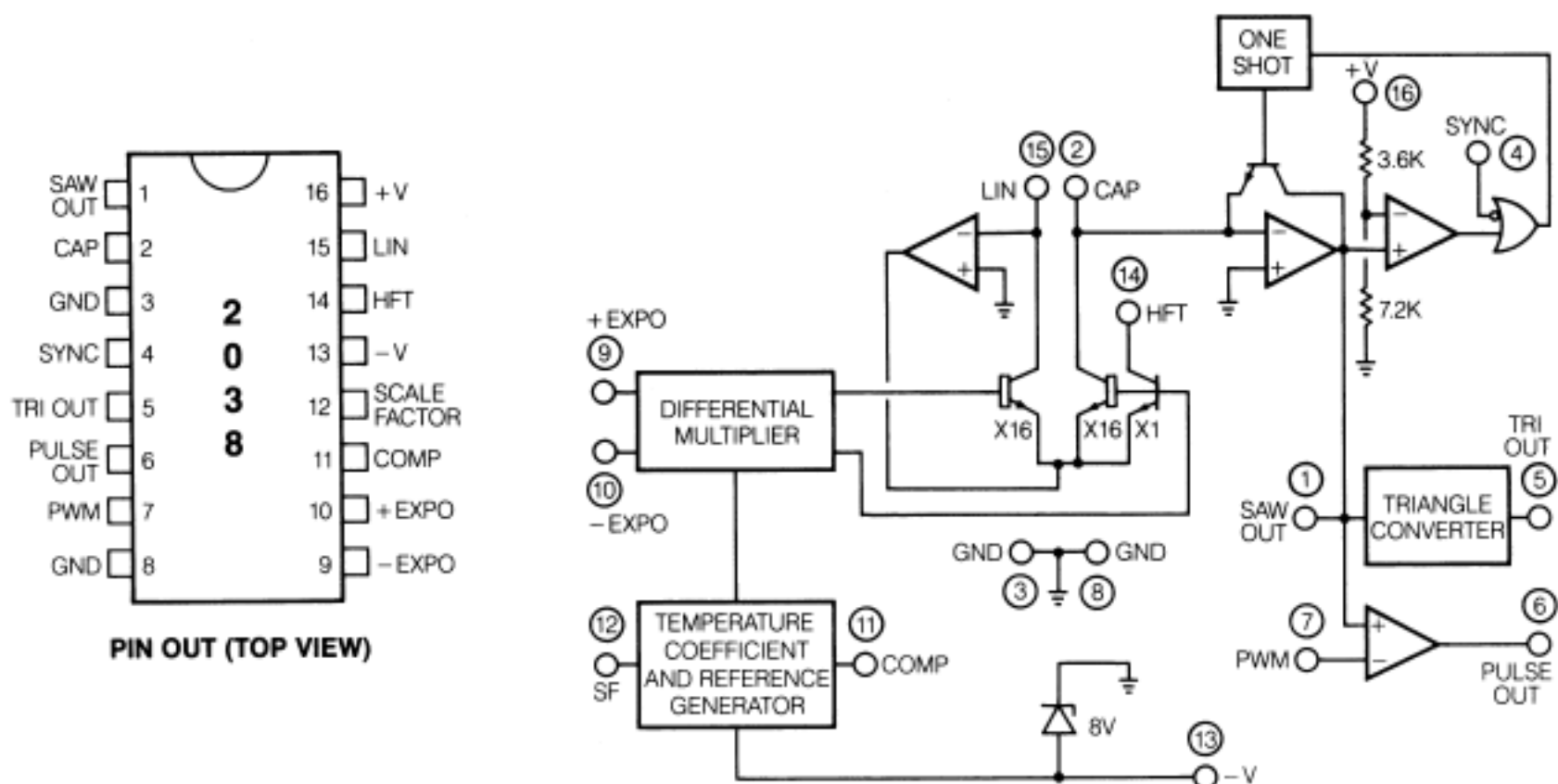
The SSM 2038 is a precision voltage controlled oscillator designed specifically for electronic music purposes. Operating frequency can be swept over a 5,000:1 range by simultaneous linear and exponential control inputs. Additionally, exponential conversion is fully differential yielding both positive and negative inputs, which simplifies system design. The 2038 is fully temperature compensated and needs no compensating resistor or continuous computer aided retuning.

Three buffered outputs are provided: sawtooth, triangle and pulse. The latter has a voltage controlled duty cycle from 0 to 100%, clean edges being guaranteed by a comparator with internal hysteresis.

The 2038 also features provision for synchronization, high frequency track compensation and voltage controlled scale factor trim.

FEATURES

- Internal Temperature Compensation
- Low Scale Factor Drift (75ppm)
- 5,000:1 Sweep Range
- Linear and Exponential Control Inputs
- Excellent Exponential Conformity (0.2%)
- Short Circuit Protected Outputs
- Voltage Controlled Pulse Width
- No Trimming Required For Most Applications (Voltage Controlled Scale Factor Adjustment)



The following specifications apply for $V_s = \pm 15V$, $R_{LIMIT} = 1.5k\Omega$, $T_A = 25^{\circ}C$.

PARAMETER	MIN	TYP	MAX	UNITS	CONDITIONS
Positive Supply Current	8		14	mA	
Negative Supply Current	2.5	3.2	3.84	mA	
Positive Supply Voltage Range	9	15	18	V	
Negative Supply Voltage Range (Note 1)	– 18	– 15	– 4.5	V	
Sweep Range	2000	5000			
Integrator Bias Current		0.3	1	nA	
Max Operating Frequency	22	28	34	kHz	$C_1 = 1000pF$
Max Charging Current	0.22	0.28	0.34	mA	
Exponential Conformity		0.15	0.25	%	$C_1 = 1000pF$, $50Hz \leq F \leq 5000Hz$ Circuit of Figure 4a
Sawtooth Upper Level	9.85		10.15	V	
Sawtooth Discharge Level		200	350	mV	
Sawtooth Discharge Time		100		nS	
Sawtooth Short Circuit Current	5.6	7.5	9.4	mA	
Pulse Upper Level	5.65		7.35	V	
Pulse Lower Level	– 100		+ 100	mV	Pin 6 has 15k to Ground @ 50Hz
Pulse Rise Time		3		μS	
Pulse Fall Time		1		μS	
PWM Bias Current		0.6	5	μA	
Pulse Short Circuit Current		12	20	mA	
Triangle Upper Level	4.85		5.15	V	
Triangle Lower Level		± 75	± 200	mV	
Triangle Short Circuit Current	6		10	mA	
Exponential Scale Factor	17.4	17.9	18.5	mV/octave	Untrimmed
Multiplier Offset (Note 2)		0.5	3.0	mV	
Multiplier Input Bias Current		500	1000	nA	$V_e = 0$
Multiplier Input Offset Current		50	250	nA	$V_e = 0$
Oscillator Drift (Note 3)			± 50	ppm/ $^{\circ}C$	$V_e = 0$
Exponential Scale Factor Drift (Note 3)		± 75	± 200	ppm/ $^{\circ}C$	$V_e = V_T = \pm 25.9mV$ @ 25°C

Note 1: Series current limiting resistor required for negative supplies greater than – 6V.

Note 2: This is the voltage that must be applied between the expo inputs to force the integrator current to equal the current flowing into pin 15.

Note 3: Excludes drift of external components. Max limits for drift guaranteed by sample testing.

Synchronization

The 2038 can be synchronized to falling waveform edges (such as the sawtooth output of another 2038) by A.C. coupling the waveform into pin 4. Synchronization causes an immediate discharge of the 2038 timing capacitor.

Scale Factor Adjustment

Normally, scale factor adjustment will be performed either by altering the input resistor to the exponential converter or the associated 200Ω attenuator resistor. In applications where automatic adjustment is needed, it is possible to obtain a voltage controlled scale factor trim (figure 3). A control voltage of 2.5V will leave the scale factor unchanged and variation from zero to five volts will produce $\pm 5\%$ of adjustment. Trimming the scale factor in this manner does cause a slight increase in drift but the effect is small: only about $10\text{ppm}/^\circ\text{C}$ per percent of adjustment.

High Frequency Tracking

Although the exponential conformity of the 2038 is extremely good, provision has been made to provide an improvement at frequencies above 5kHz. Figure 4a shows recommended use of the high frequency track pin (pin 14) which extends accuracy to above 10kHz. In very critical applications, the high frequency tracking can be trimmed (figure 4b). VR_1 should be adjusted to give the same scale factor at high frequencies as at low frequencies. If pin 14 is not used it must be connected to ground. A polystyrene type timing capacitor is required for best exponential conformity at hi frequencies.

2038 Negative Supply

The 2038 negative supply (pin 13) is internally regulated at about -8V and a current limiting resistor is required when a -15V supply is used. A value of $1.3\text{k}\Omega$ is recommended in most applications.

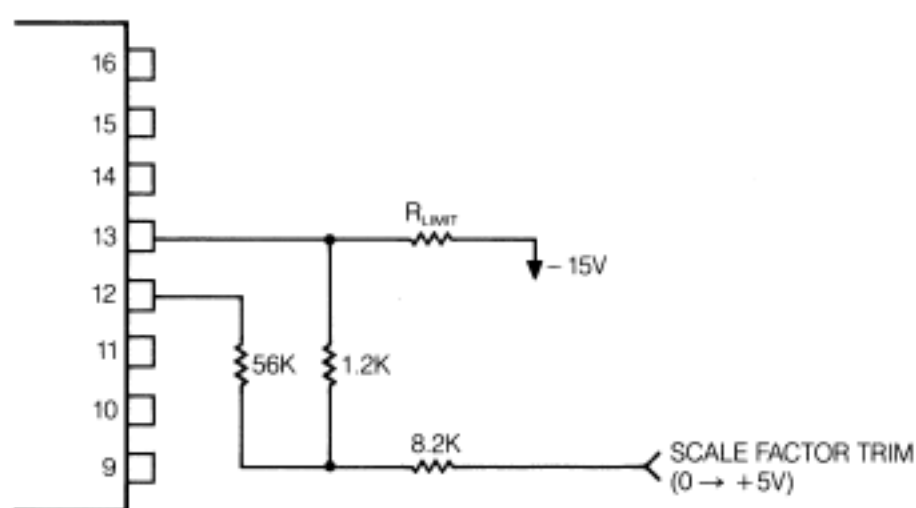


FIGURE 3. VOLTAGE CONTROLLED SCALE FACTOR TRIM

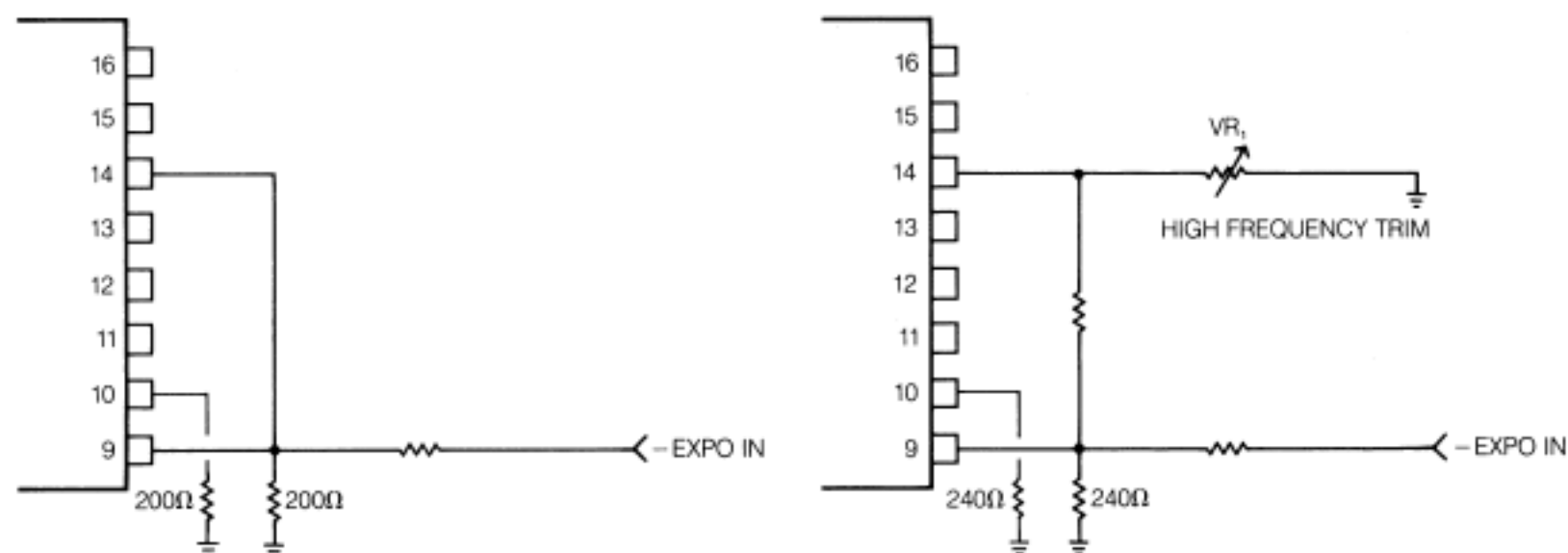


FIGURE 4. USING THE HIGH FREQUENCY TRACK PIN

Principle of Operation

Referring to figure 1 an exponential current generator feeds an integrator whose output is reset to zero when it ramps to +10V. This process repeats at a rate proportional to the current generated by the exponential circuit. The reset time is only 100nS, and over the audio frequency range yields a sawtooth wave of almost perfect shape. This waveform is then further processed by the triangle converter and pulse comparator.

Exponential converters normally have a scale factor inversely proportional to temperature. This effect is eliminated on the 2038 by a differential multiplier which produces an equal but opposite term in the overall control path. The result is that the scale factor is controlled by an internal reference circuit which is very temperature stable.

A typical connection for the 2038 is shown in figure 2.

Exponential Inputs

The exponential inputs operate with a nominal scale factor of 18mV/octave, and in most applications $\pm 90\text{mV}$ control levels will be used to cover a full 10 octave range. The exponential inputs are most accurate when fed from 200Ω of source resistance. This can conveniently form part of the input attenuator. The values used in figure 2 are for a scale factor of 1 volt/octave. If one of the inputs is not used it should be grounded through a 200Ω resistor.

Linear Input

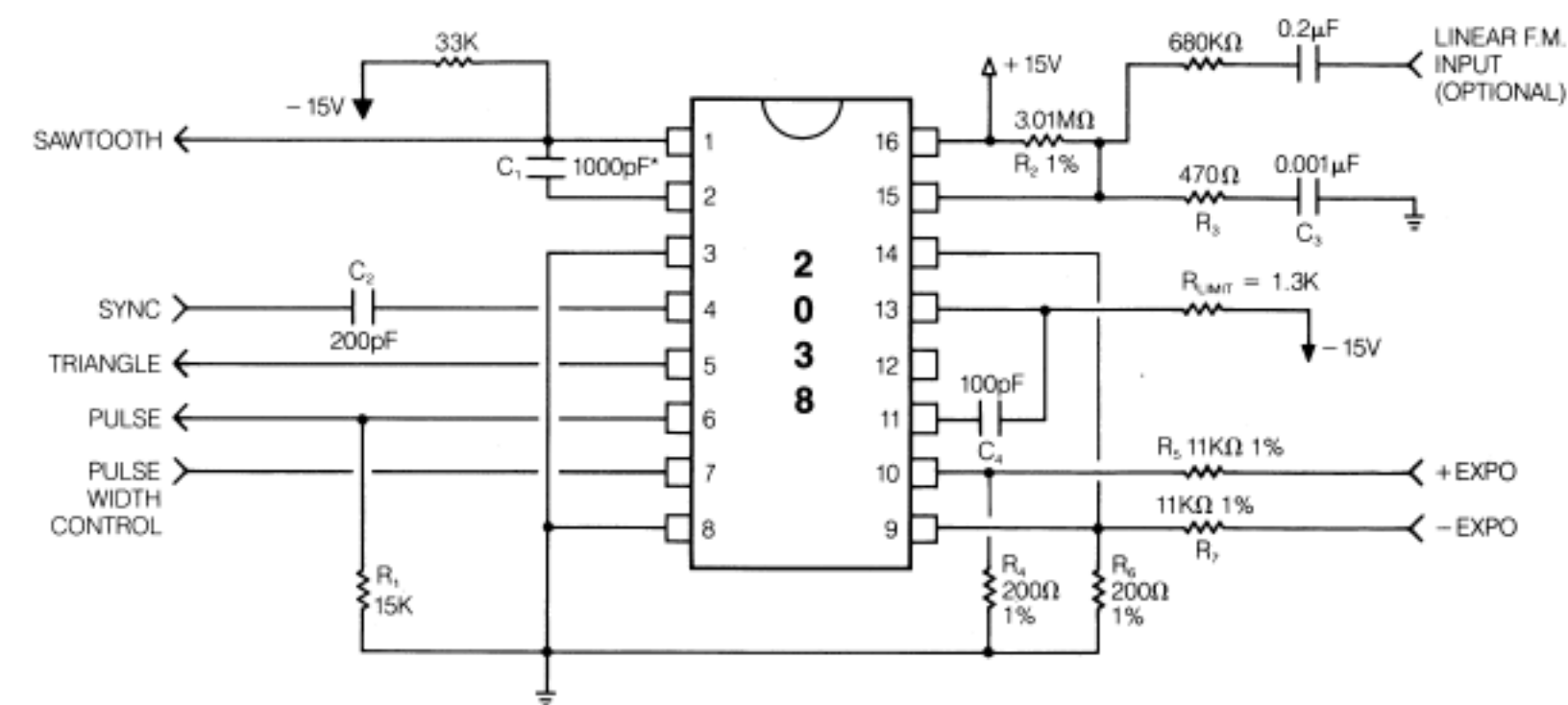
The linear input is a virtual ground current input, providing proportional control with a scale factor of $100\text{Hz}/\mu\text{A}$ with no exponential input and with the recommended 1000pF timing capacitor (C_3 and R_3 provide phase compensation for the internal control amplifier). It should be noted that the operating frequency is also inversely proportional to positive supply voltage. This is not a problem in exponential systems since the linear input can also be derived from the supply (as in figure 2) and the two effects cancel. If the linear input is used as a separate control input, however, then the positive supply should be regulated. In exponential applications, a value of $5\mu\text{A}$ of linear current is recommended which will cause the oscillator to run at 500Hz with no exponential input.

Waveform Outputs

The waveform outputs are guaranteed to source 4mA of output current and are all fully protected against short circuits to ground. The lower waveform levels are nominally 0V; the sawtooth, triangle and pulse having +10V, +5V and +6.5V peak outputs respectively.

Pulse Width Control

With +5V at the PWM control (pin 7) the pulse has a 50% duty cycle. Varying the PWM control voltage from 0 to 10V will sweep the duty cycle through its full range.



*POLYSTYRENE

FIGURE 2. TYPICAL CONNECTION.