

SSM 2020

DUAL LINEAR-ANTILOG VOLTAGE CONTROLLED AMPLIFIER

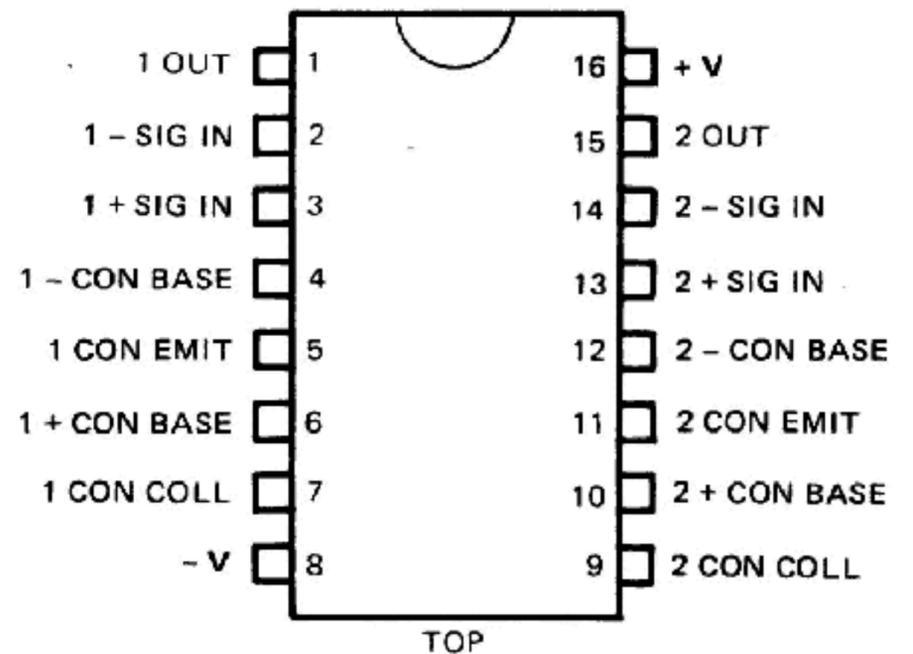
The SSM 2020 is a dual two quadrant multiplier designed to be used with op amps in a wide variety of precision audio-frequency applications including AGC circuits, Dividers and as a Biquad tuning element. Each channel has separate control and differential signal inputs and a current output. The device offers an exceptionally flexible control circuit for each channel which allows simultaneous linear and exponential voltage control of gain or either polarity of current control. Both channels are fully temperature compensated and have 84dB signal to noise ratios at less than 0.1% distortion.

FEATURES

- Max Supplies $\pm 18V$
- Dual Design (Independent Control Selection)
- 2% Channel Gain Matching
- 100dB Control Range
- Simultaneous Linear and Exponential Gain Control
- Differential Signal Inputs
- Current Output
- 84dB Signal to Noise
- 0.1% Distortion
- Fully Temperature Compensated

APPLICATIONS

- 2 and 4 Quadrant Multipliers
- Dividers
- AGC Circuits
- Voltage Controlled Filters
- Voltage Controlled Quadrature Oscillators
- Volume Controls
- Equalizers
- Compandors
- Antilog Amplifiers
- Voltage Controlled Current Sources

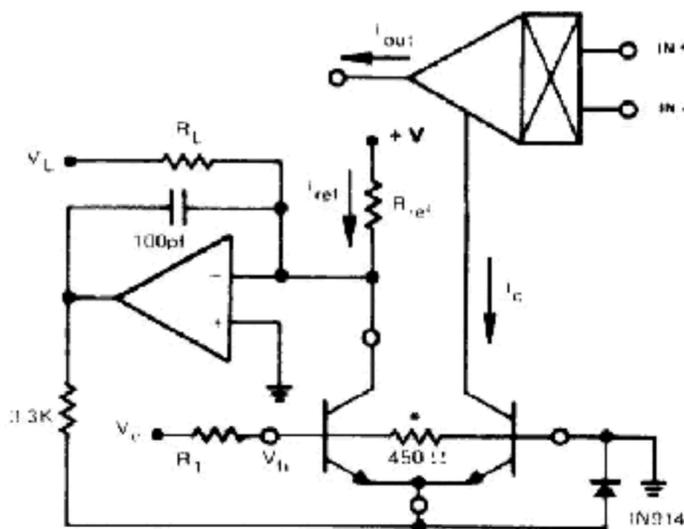


$$1) I_{out} = g_m (V_+ - V_-)$$

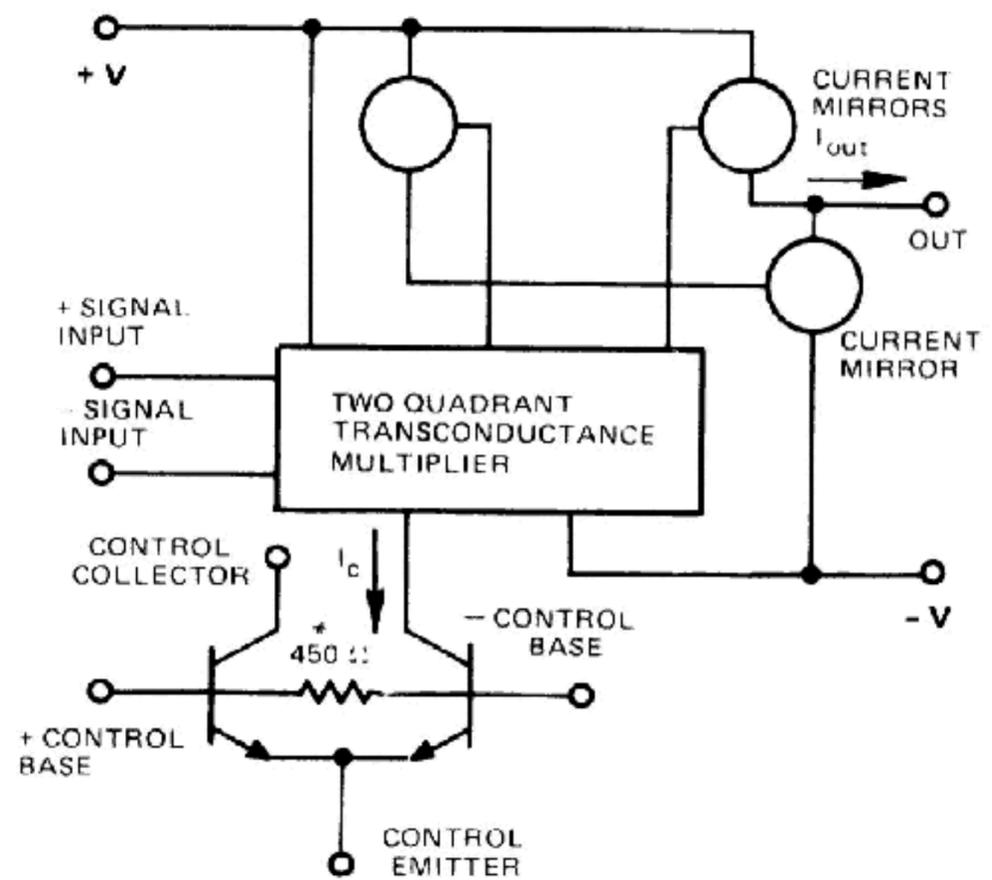
$$2) I_{out} = \frac{I_c (V_+ - V_-)}{14 \text{ volts}}$$

$$3) I_c = e^{-V_b q / KT} (+ V / R_{ref} + V_L / R_L)$$

where $V_b = \frac{V_c 450 \Omega}{R_1 + 450 \Omega}$



Basic Control Circuit



Block Diagram (One Side)

*NOTE: THE 450 Ω RESISTORS ARE INTERNAL TO THE I.C. AND COMPENSATE FOR THE T FACTOR IN THE EXPONENT.

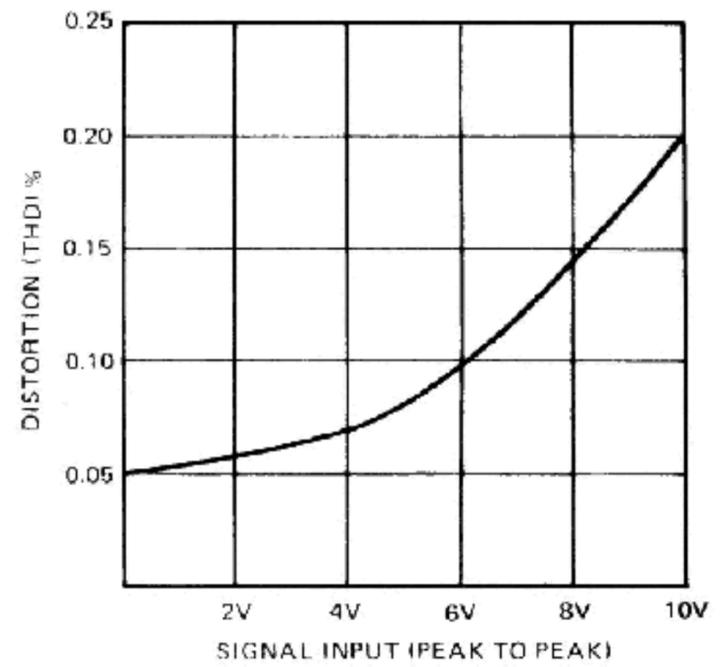
Operating Temperature -25°C to $+75^{\circ}\text{C}$

Storage Temperature -55°C to 125°C

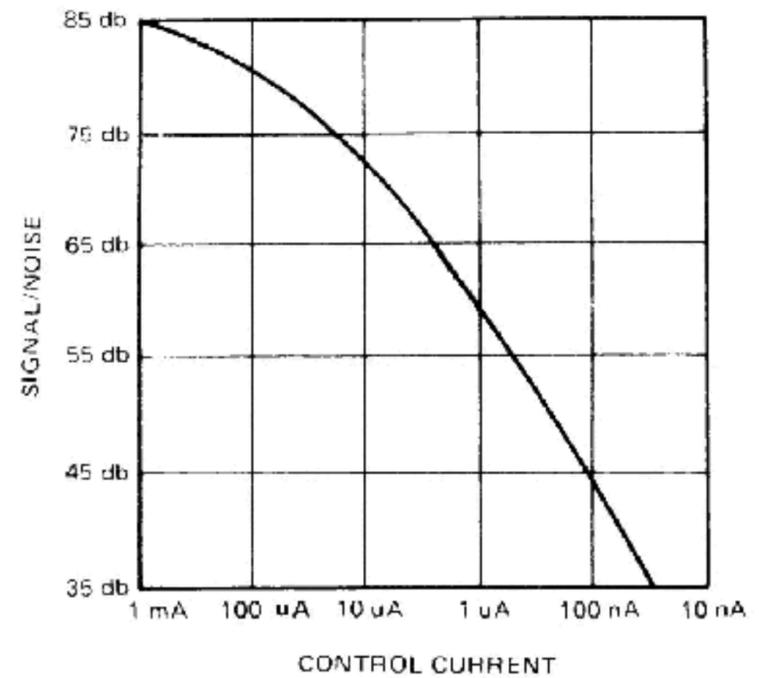
Specifications @ $V_S = \pm 15\text{V}$, $I_{c1} = I_{c2} = 500\ \mu\text{A}$ and $T_A = 25^{\circ}\text{C}$, unless otherwise specified.

Parameters	Min	Typ	Max	Conditions
Signal Input Bias I_B		500 nA	2.2 μA	$V_{EE} + 3\text{V} < V_+, V_- < V_{CC} - 3\text{V}$
Supply Voltage V_S	± 6	± 15	± 18	
Supply Current I_S		6 mA	8 mA	$I_{c1} = I_{c2} = 1\ \text{mA}$
Control Current			1 mA	
Transconductance gm	1/12 k Ω	1/14 k Ω	1/16 k Ω	$I_{c1} = I_{c2} = 1\ \text{mA}$
gm match		$\pm 2\%$	$\pm 5\%$	
gm Tempco		100 ppm/ $^{\circ}\text{C}$		
Control Circuit V_{OS}		1 mV	3 mV	
Output Offset I_O/I_C		$\pm 2\%$	$\pm 10\%$	$V_+ = V_- = \text{GND}$ (untrimmed)
Control Rejection		60 dB		$0 \leq I_C \leq 1\ \text{mA}$ (trimmed)
450 Ω Resistor	350 Ω	450 Ω	550 Ω	
450 Ω Temp Coef		$\pm 2000\ \text{ppm}/^{\circ}\text{C}$		
Channel Separation		100 dB		$F = 1\ \text{kHz}$
Bandwidth (3 dB)		1 MHz		$I_C = 1\ \text{mA}^*$
		300 kHz		$I_C = 10\ \mu\text{A}$
		30 kHz		$I_C = 100\ \text{nA}$
Feedthrough:				
-Input to Output		90 dB		$F = 1\ \text{kHz}, I_C = 0$
+Input to Output		100 dB		$F = 1\ \text{kHz}, I_C = 0$
Signal/Noise		84 dB		$V_S = 6\ \text{V}_{pp}, I_C = 1\ \text{mA}$
Distortion (THD)				
VCA (Open Loop)		0.1%		$V_S = 6\ \text{V}_{pp}, I_C = 1\ \text{mA}$
VCF (Closed Loop)		0.02%		$V_S = 6\ \text{V}_{pp}, I_C = 1\ \text{mA}$
As below				

* Output at Virtual GND



Distortion vs Signal Input



Signal Noise vs Control Current (6 Vpp in)

VCF Design Equations

$$R = 15\text{K}, R_a C \omega_0 = 1$$

$$R_a = 28\text{K} @ I_C = 500\ \mu\text{A}$$

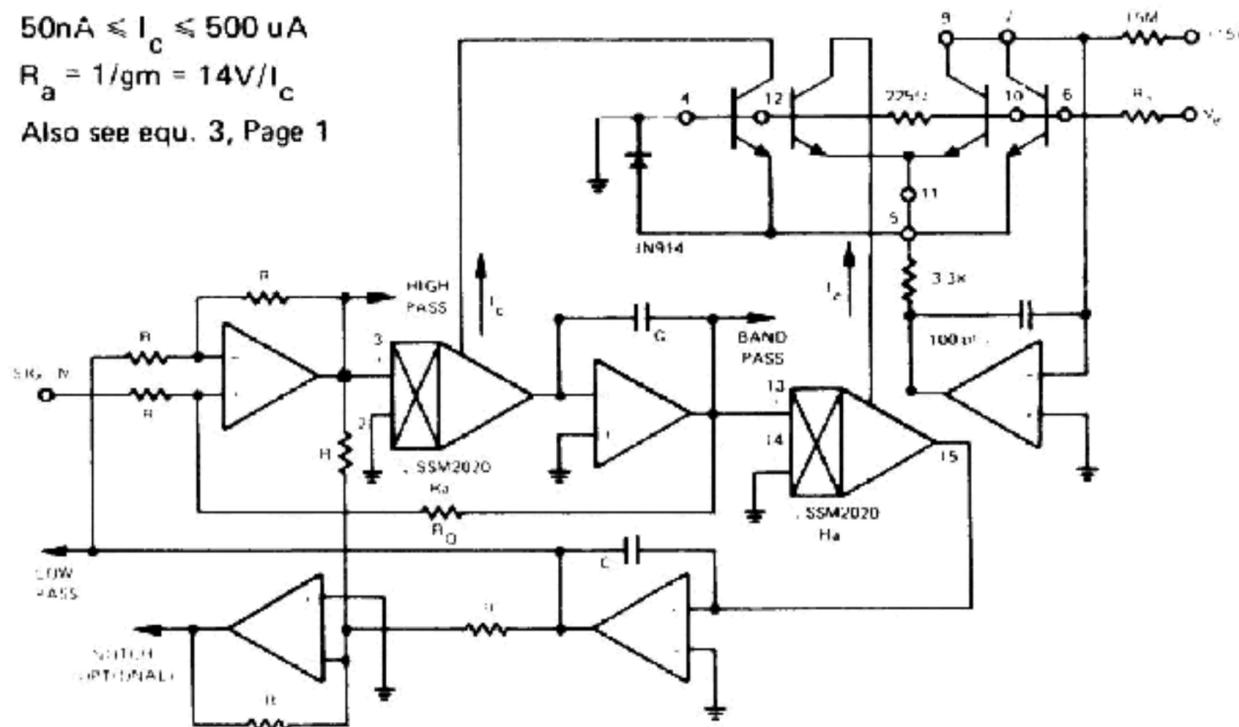
$$R_O = (2Q - 1) R$$

$$A = 2 - 1/Q$$

$$50\text{nA} \leq I_C \leq 500\ \mu\text{A}$$

$$R_a = 1/g_m = 14\text{V}/I_C$$

Also see equ. 3, Page 1



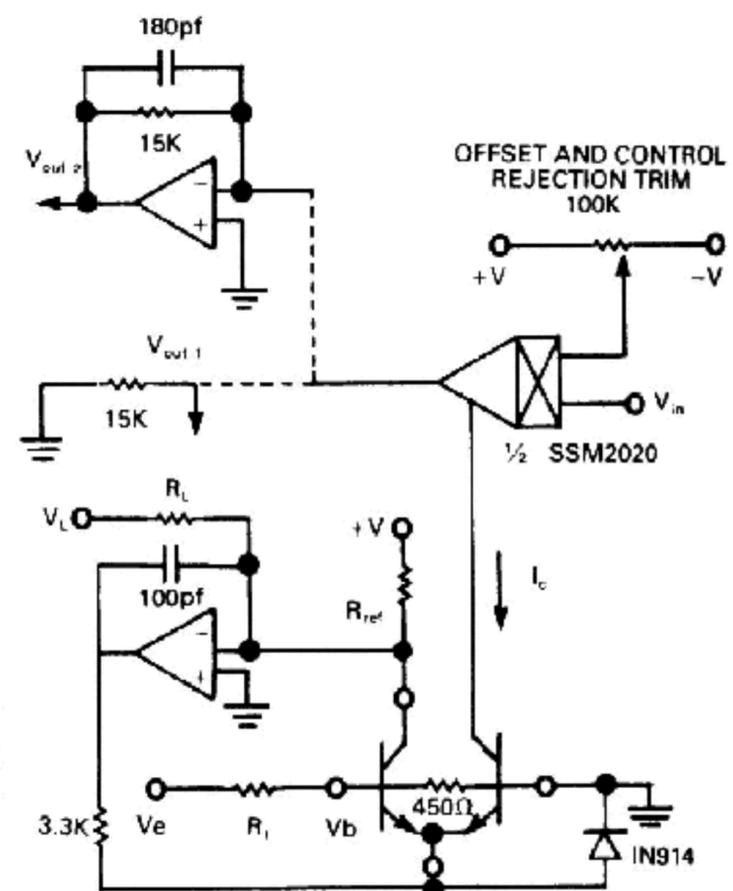
Voltage Controlled Filter (10,000 to 1 Sweep)

VCA Design Equations

$$V_{out} = I_C V_{in} 15\text{K}/14\text{Volts}$$

$$I_C = e^{-V_b q/KT} (V_-/R_{ref} + V_+/R_i)$$

$$V_b = V_e 450\Omega / (R_i + 450\Omega)$$



Voltage Controlled Amplifier