Solid State Micro Technology for Music

SSM 2020

DUAL LINEAR-ANTILOG VOLTAGE CONTROLLED AMPLIFIER

DESCRIPTION

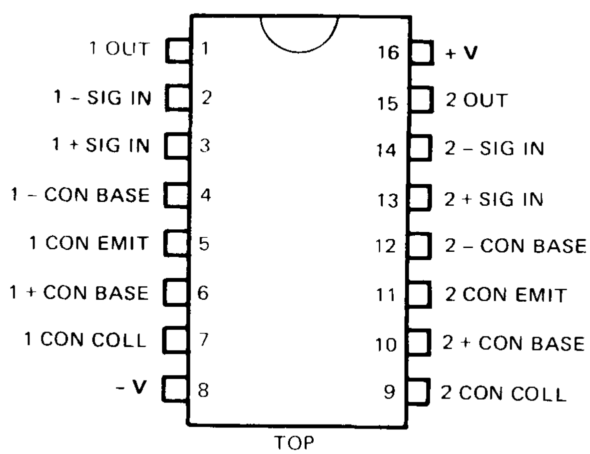
The SSM 2020 is a dual two quadrant multiplier designed to be used with op amps in a wide variety of precision audi-frequency applications including AGC circuits, Dividers and as a Biquad tuning element. Each channel has separate control and differential signal inputs and a current output. The device 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 86 dB signal-to-noise ratios at less than 0.1% distortion

FEATURES

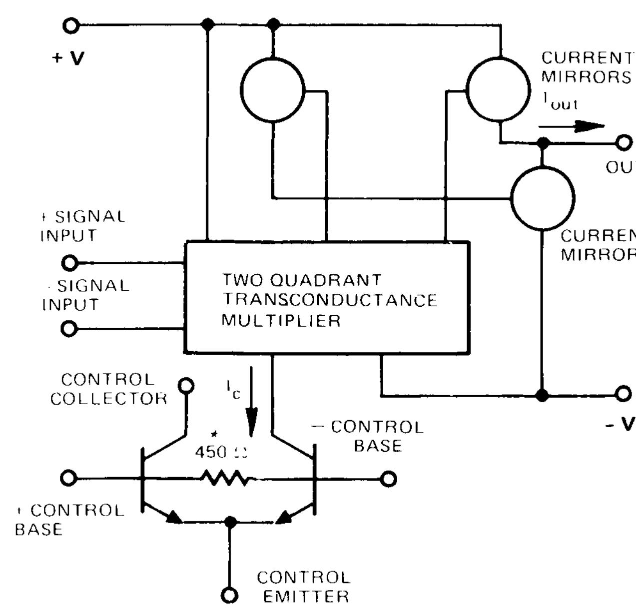
- Max Supplies ± 18V
- Dual Design (Independent Control Selection)
- 2% Channel Gain Matching
- 100 dB Control Range
- Simultaneous Linear and Exponential Gain Control
- Differential Signal Inputs
- Current Output
- 86db Signal-to-Noise
- 0.1% Distortion
- Fully Temperature Compensated

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



Pin Diagram



Equivalent Schematic (One Side)

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SPECIFICATIONS

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

PARAMETERS	MIN	TYP	MAX	CONDITIONS
Signal Input Bias I_b Supply Voltage V_s Supply Current I_s Control Current	±6	500 nA ±15 6 mA	2.2 µA ±18 8 mA 1 mA	$V_{ee} + 3V \leqslant V_+, V_- \leqslant V_{cc} - 3V$ $I_{c1} = I_{c2} = 1$ mA
Transconductance gm gm match gm Temco	1/12kΩ	1/14 kΩ +2% 100 ppm/°C	1/16 kΩ ±5%	$I_{c1} = I_{c2} = 1$ mA
Control Circuit V_{os}		1 mV	3 mV	
Output Offset I_o/I_c Control Rejection		±2% 60 dB	±10%	$V_+ = V_- =$ GND (untrimmed) $0 \leqslant I_c \leqslant 1$ mA (trimmed)
450 Ω Resistor 450 Ω Temp Coef	350 Ω	450 Ω +2000 ppm/°C	550 Ω	
Channel Separation		100 dB		F = 1 kHz
Bandwidth (3 dB)		1 MHz 300 kHz 30 kHz		$I_c = 1$ mA * $I_c = 10\ \mu A$ $I_c = 100$ nA
Feedthrough: -Input to Output + Input to Output		90 dB 100 dB		F = 1 kHz, $I_c = 0$ F = 1 kHz, $I_c = 0$
Signal/Noise		86 dB		$V_s = 6\ V_{pp}$, $I_c = 1$ mA
Distortion (THD) VCA (Open Loop) VCF (Closed Loop) As below		0.1% 0.02%		$V_s = 6\ V_{pp}$, $I_c = 1$ mA $V_s = 6\ V_{pp}$, $I_c = 1$ mA

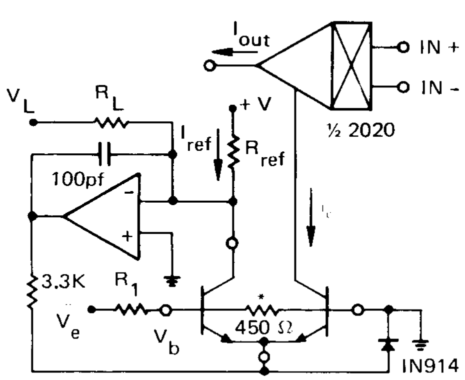
*Output at Virtual GND

OPERATING TEMPERATURE

-25° C to +75° C – Commercial
-55° C to +125° C – Military

STORAGE TEMPERATURE

-55° C to 125° C



Basic Control Circuit

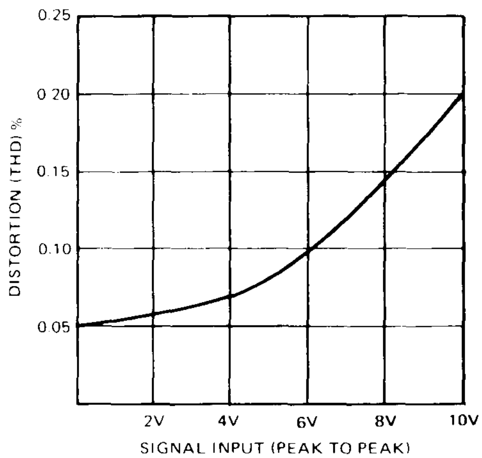
1) $I_{out} = g_m (V_+ - V_-)$

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

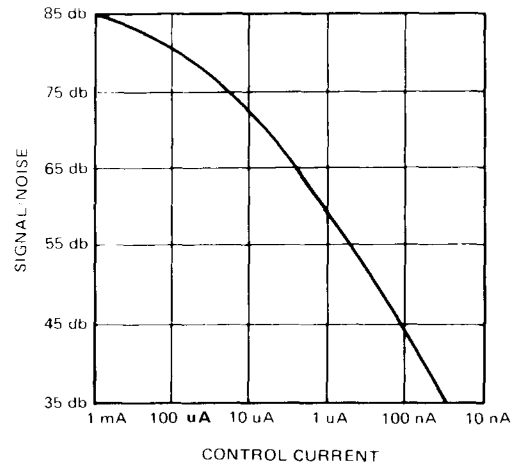
3) $I_c = e^{-V_b q/KT} (+V/R_{ref} + V_L/R_L)$

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

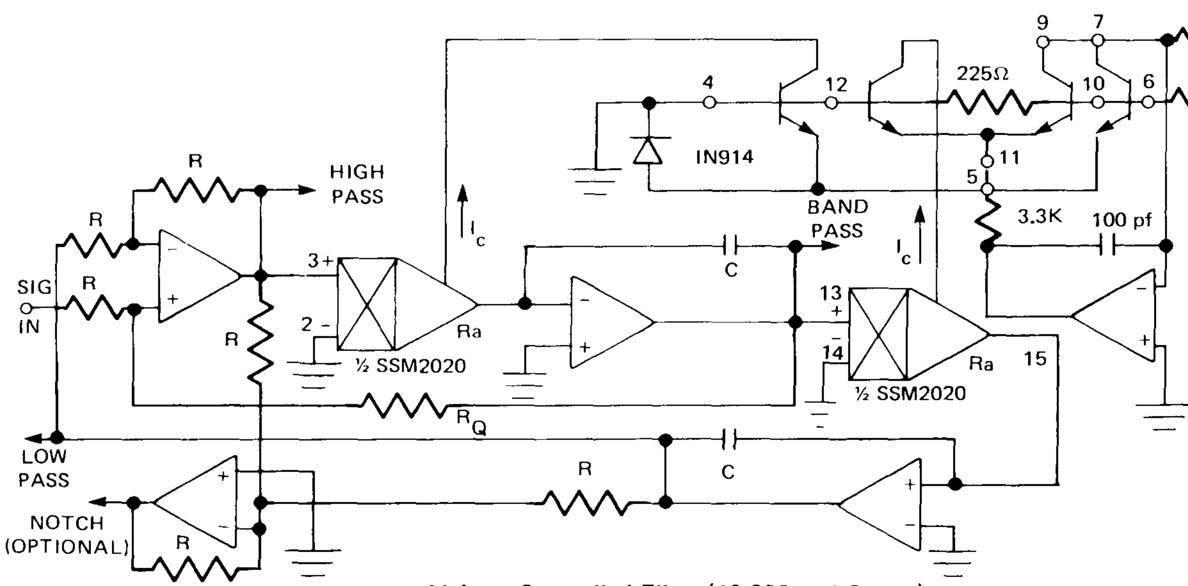
*NOTE: THE 450 Ω RESISTORS ARE INTERNAL TO THE I.C. AND COMPENSATE FOR THE T FACTOR IN THE EXPONENT.



Distortion vs Signal Input



Signal Noise vs Control Current (6 Vpp in)



VCF Design Equations

R = 15K, $R_a C\omega_o = 1$

R_a = 28K @ I_c = 500 uA

$R_Q = (2Q - 1) R$

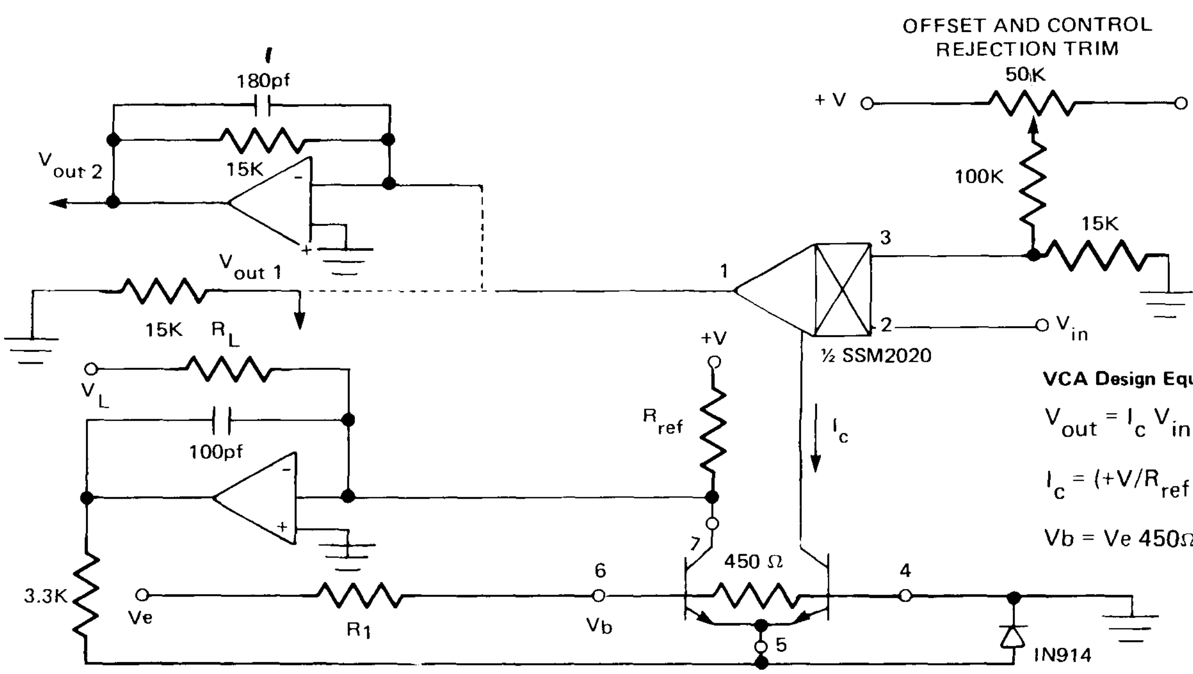
$A = 2 - 1/Q$

$50nA \leqslant I_C \leqslant 500$ uA

$R_a = 1/gm = 14V/I_c$

Also see equ. 3, Page 2

Voltage Controlled Filter (10,000 to 1 Sweep)



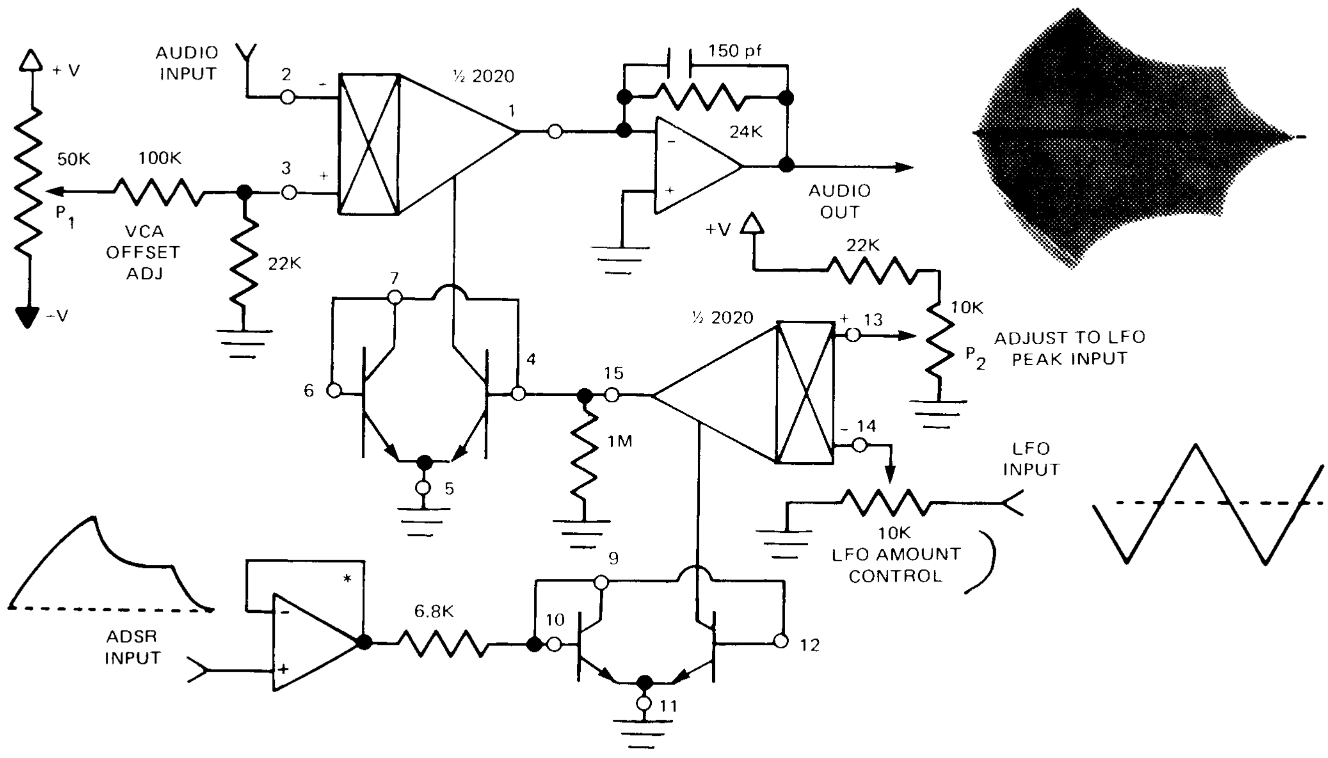
VCA Design Equations

$V_{out} = I_c V_{in}$ 15K/14 Volts

$I_c = (+V/R_{ref} + V_L/R_1)\, e^{-V_b q/KT}$

$V_b = V_e\ 450\Omega / (R_1 + 450\Omega)$

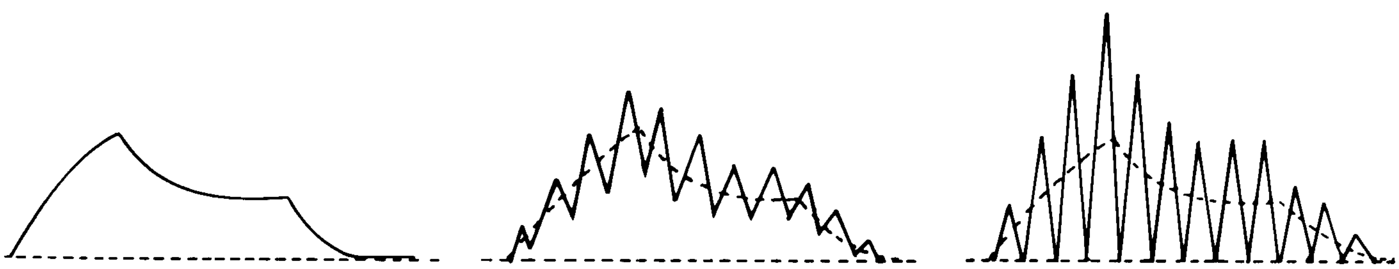
Voltage Controlled Amplifier



A single 2020 can be connected to add tremello to the output envelope of a VCA. Tremello depth can be controlled from 0 to 100%. The adjustment procedure is to apply an audio input to the VCA, turn the LFO amount control all the way on and gate and hold on the ADSR. Trimpot P_2 is then adjusted to give 100% modulation at the VCA output. The VCA offset trimpot P_1 is then adjusted to center the VCA output about ground.

VCA Control Envelopes

0% LFO MODULATION | 30% LFO MODULATION | 100% LFO MODULATION



*Buffer required if driving 6.8K load from output of SSM 2050. Not needed for SSM 2055.

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