National Semiconductor

PRELIMINARY

LH4200 General Purpose GaAs FET Amplifier

General Description

This is a general purpose low noise, AC coupled, high frequency amplifier useful for applications from 500 KHz to 1 GHz. It features a Gallium Arsenide input stage for high frequency performance and bipolar second and third stages for low output impedance. Series feedback may be provided for gain stabilization and input impedance improvement. A control input is available to vary the open loop gain of the amplifier making it useful for AGC and mixer applications.

Features

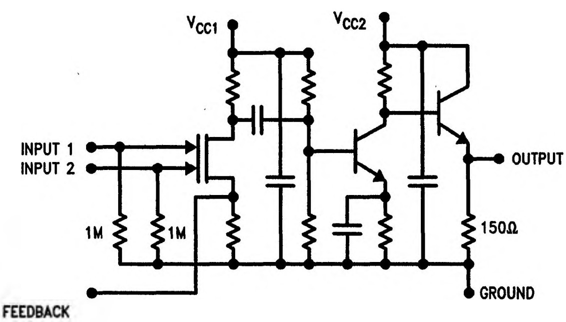
- High gain 38 dB at 100 MHz
- Wide AGC range 60 dB at 100 MHz
- High input impedance 1 MΩ
- Low noise figure 3 dB, 50Ω

Applications

- Voltage Controlled Amplifiers
- Feedback Stabilized Amplifiers
- Mixer-Amplifiers
- HF-UHF Oscillators
- Video Diode Receivers
- Fiber Optics

Simplified Schematic

High Frequency Amplifier



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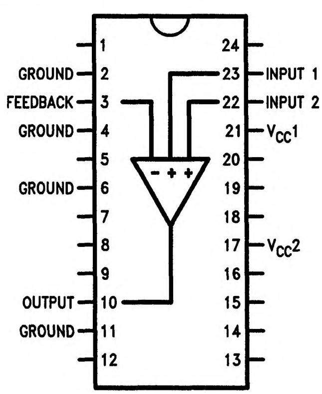
Connection Diagrams



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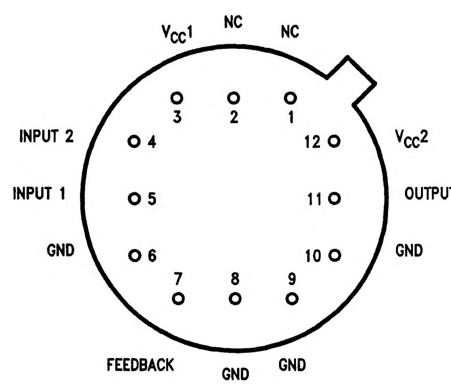
Top View

Order Number LH4200CD
See NS Package Number D24D



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Top View

Order Number LH4200G
See NS Package Number G12B

Note: Unspecified pins are No Connection.

Absolute Maximum Ratings

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications.

Supply Voltage (V_{CC1}, V_{CC2})	12V
Power Dissipation (P_D) at T_A = 25°C	980 mW
Output Current (I_O)	40 mA
Voltage	
Input 1	+1.4 to −4V
Input 2	+2.5 to −4V
Operating Temperature Range	
LH4200C	−25°C to +85°C
LH4200G	−55°C to +125°C
Storage Temperature Range (T_{STG})	−65°C to +150°C
Maximum Junction Temperature (T_J)	150°C
Lead Temperature (Soldering < 10 sec.)	300°C
ESD Tolerance (Note 1)	150V

DC Electrical Characteristics

Unless otherwise specified. V_{CC} = V_{CO} = 10V, R_S = 50Ω, R_L = 50Ω, T_A = 25°C (Note 4)

Symbol	Description	Conditions	Typ	Tested Limit (Note 2)	Design Limit (Note 3)	Units
V_{10}	Output Bias Voltage		5		**4.5**	V (Min)
V_3	FET Source Bias	V_{IN1} = V_{IN2} = 0V	0.6	0.5	**0.4**	V (Min)
V_0	Output Voltage Swing	100 kHz	3			V_{P-P}
I_S	Supply Current		45	70		mA (Max)
Z_{IN}	Input Impedance		1 Meg	200k		Ω (Min)

AC Electrical Characteristics

Unless otherwise specified. V_S = 10V, R_S = 50Ω, R_L = 50Ω, T_A = 25°C (Note 4)

Symbol	Description	Conditions	Typ	Tested Limit (Note 2)	Design Limit (Note 3)	Units
S21	Power Gain (Note 4)	10 MHz V_{IN1} = 0V, V_{IN2} = +1.5V	50	42		dB
		100 MHz V_{IN1} = 0V, V_{IN2} = +1.5V	37	30		dB
		500 MHz V_{IN1} = 0V, V_{IN2} = +1.5V	18	14		dB
		1000 MHz V_{IN1} = 0V, V_{IN2} = +1.5V	3			dB
P_1	Power Output @1 dB Compression	10 MHz	15	12		dBm
		100 MHz	14	10		dBm
		500 MHz	6	4		dBm
		1000 MHz	1			dBm
	AGC Range	100 MHz, V_{G2} = −2V	60			dB
NF	Noise Figure	10–500 MHz, R_S = 50	3			dB
		R_S = 800	2			dB

Note 1: Human body model, 100 pF discharged through a 1.5 kΩ resistor.

Note 2: Tested limits are guaranteed and 100% tested in production.

Note 3: Design limits are guaranteed (but not 100% production tested) over indicated temperature and supply voltage ranges. These limits are not used to calculate outgoing quality levels. Boldface limits are guaranteed over full temperature range.

Note 4: These measurements are taken with the LH4200 open loop.

General Information

The LH4200 is useful for a variety of RF, VHF, and UHF applications including feedback, AGC amplifiers, and signal sources. The amplifier is internally bypassed for good high frequency performance, but should be bypassed externally with a large (10 μF aluminum electrolytic or better) capacitor to prevent low frequency stability (oscillation) problems.

The amplifier has three inputs: Two high impedance gates for signal input, and a low impedance source for series mode Feedback (Pin 3).

Normally, Input 1 is used as the signal input while Input 2 is used to control the gain of the amplifier for those applications using Automatic Gain Control (AGC). Gain control ranges of over 60 dB are possible to 100 MHz. Input 2 is biased at +1.5V for maximum gain and −2V for minimum gain. Input 2 and Feedback (Pin 3) are normally bypassed with 0.01 μF capacitors for maximim gain.

The second gate, Input 2 may be used as a second isolated input for small signal operation. The open loop gain from this input is approximately 6 dB less than from Input 1.

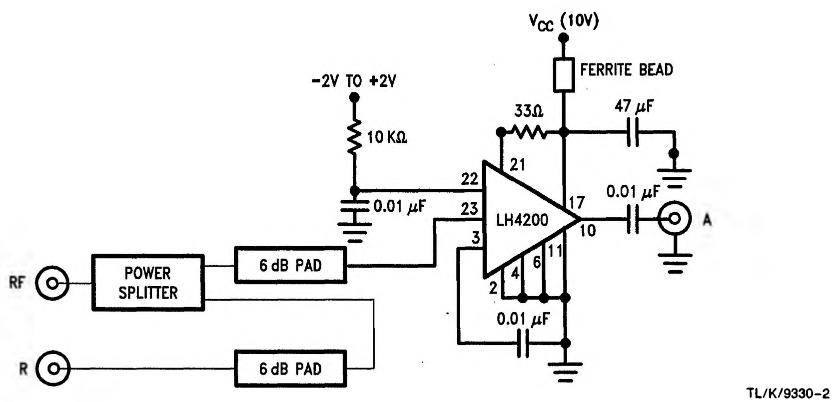
The LH4200 may be used as a feedback amplifier, in which case, the third input, Feedback, is connected to the output with a suitable resistor to set the overall power gain. In this manner, voltage series feedback is used to establish the power gain and increase input impedance. A typical connection is shown along with the feedback components needed to achieve several different gain settings. (See *Figure 5.*)

The performance of the LH4200 degrades from ideal above 250 MHz as indicated by the S parameters. The input impedance decreases and is capacitive while the output impedance increases and is inductive. For maximum performance in the 250 MHz to 900 MHz area, some performance improvement can be obtained with suitable matching networks.

LH4200 TYPICAL S PARAMETERS

$V_{CC1} = V_{CC2} = 10V, V_{Input\ 2} = 1.5V$

Frequency	S11		S21		S12	S22	
MHz	Mag	Ang	dB	Ang	dB	Mag	Ang
10	0.96	−0.5	50	−49	−48	0.99	181
100	0.97	−15	36	−130	−45	0.93	152
250	0.86	−32	26	150	−43	0.93	115
500	0.64	−62	18	39	−40	0.82	73
750	0.41	−105	10	70	−33	0.7	52
1000	0.23	168	3.5	−160	−37	0.71	42



Note: Pinout shown for D24D package.

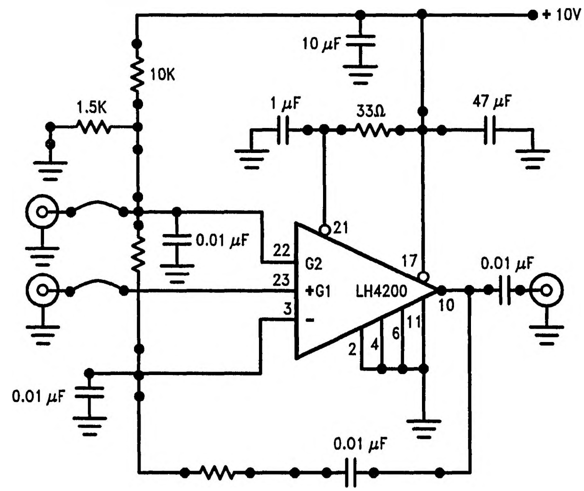
Ferrite Bead

Stackpole 57 0257

RF, R, A: HP8505A Network Analyzer Connections

FIGURE 1. S21 Measurement Circuit

General Information (Continued)



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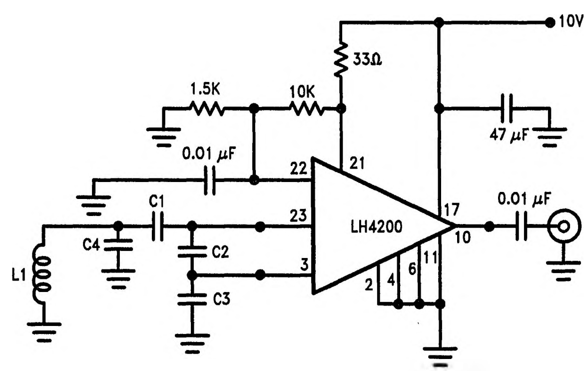
Note: Pinout shown for D24D package.

FIGURE 2. Applications Board



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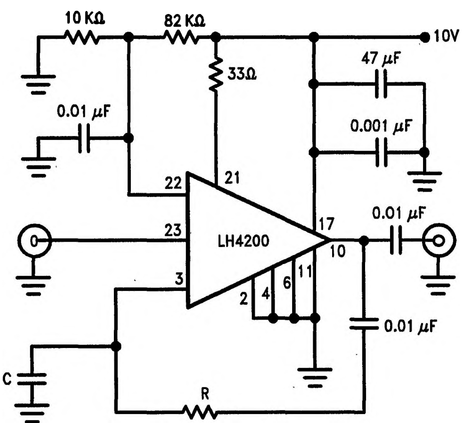
Note: Pinout shown for D24D package.

FIGURE 3. VHF-UHF Oscillator

General Information (Continued)

The LH4200 may be used as a Colpitts Oscillator to above 500 MHz (see *Figure 3*). It is stable and features load isolation and will provide +15 dBm to a 50Ω load. Capacitors C2 and C3 provide feedback from source to gate of the input GaAs FET. The resonator network, L1-C4, is coupled to the active device through C1. Approximate values suitable for beginning design are:

Frequency	C1	C2	C3	L1
MHz	pF	pF	pF	nH
75-150	5	30	60	150
150-300	3	6	10	100
300-500	1.5	3	6	50



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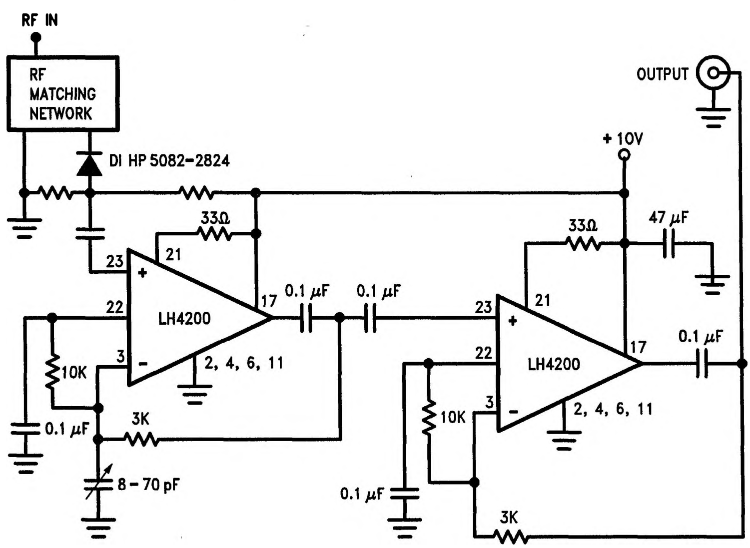
Note: Pinout shown for D24D package.

FIGURE 5. Feedback Amplifier

Gain	Bandwidth	R	C
30 dB	150 MHz	1.5k	9-30 pF
25 dB	300 MHz	860Ω	2-8 pF
20 dB	500 MHz	430Ω	<1 pF



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Note: Pinout shown for D24D package.

FIGURE 6. Video Diode Receiver (Opto or RF)

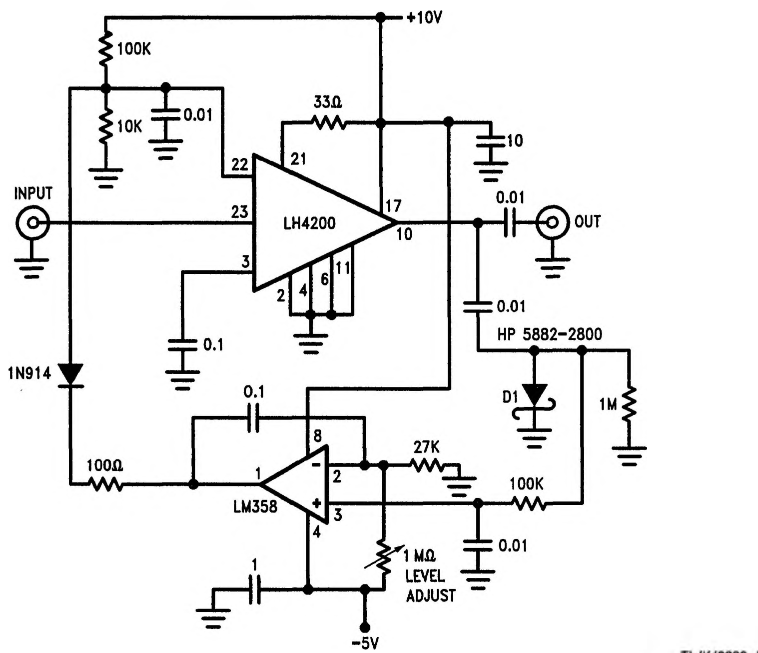
LH4200 Video Diode Receiver

The LH4200 may be used for crystal video receiver applications (see *Figure 6*). Crystal video receivers, although much less sensitive than their superhetrodyne counterparts, offer the advantage of simplicity. Typical applications include receivers for radar beacons, missile guidance, fuze activation and countermeasures; as well as signal monitoring and power leveling detectors.

This circuit shows two LH4200 amplifiers cascaded to provide a gain of 60 dB with a bandwidth of over 100 MHz. Series mode feedback provides high input impedance over the operating frequency range and low noise figure from high source impedances. Measured noise figure is 7 dB from a 50Ω source and less than 4 dB from a 1 kΩ source.

AGC Application

This circuit provides a constant RF output signal level over a broad range of input signal levels (see *Figure 7*). Diode D1 provides a DC signal proportional to the RF output level. This signal is compared to a reference voltage at the input to the LM358, which in turn controls the voltage at Input 2, controlling the gain of the LH4200.



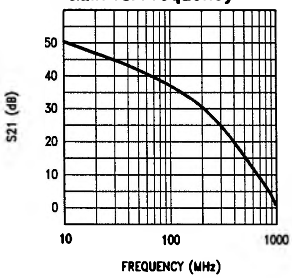
Note 1: Pinout shown for D24D package.

Note 2: All capacitance values are in microfarads.

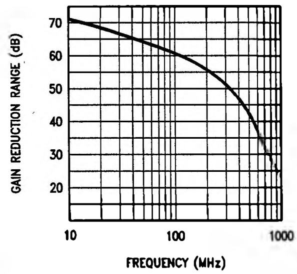
FIGURE 7. AGC Application

LH4200 Performance Characteristics

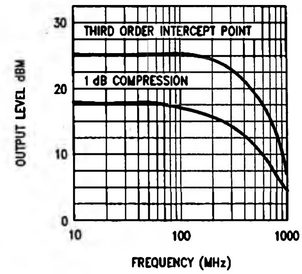
Gain vs. Frequency



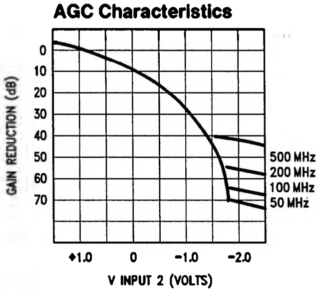
AGC Characteristics



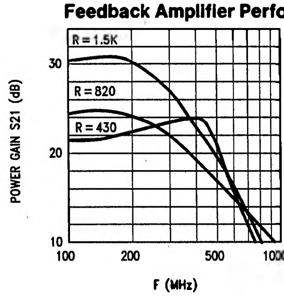
Signal Handling Capabilities



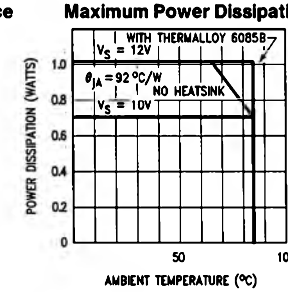
AGC Characteristics



Feedback Amplifier Performance



Maximum Power Dissipation



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