

LH4118/LH4118A/LH4118C

Low Gain Wide Band RF Amplifier

General Description

The LH4118 is a wideband amplifier optimized for high speed, low gain applications. It is an ideal alternative to low precision amplifiers. It features a closed loop -3 dB unity gain bandwidth in excess of 200 MHz. Unlike conventional op-amps, the bandwidth is relatively independent of closed loop gain between 1 and 5. A high current output stage is also incorporated, allowing the LH4118 to drive 50Ω terminated lines directly. It is an ideal choice for video distribution, flash converter input buffering and ATE pin driver.

Features

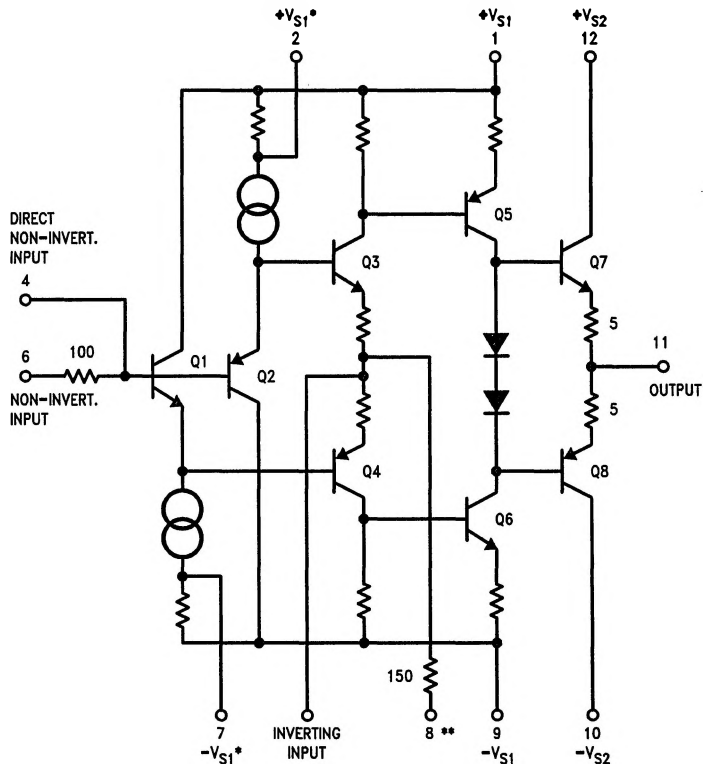
- 250 MHz bandwidth
- 15 ns settling time to 0.1%

- 2.5 ns rise and fall times
- Output current to 100 mA
- 2 mV offset voltage
- 2500 V/ μ s slew rate (100 Ω load)
- ± 0.5 dB gain flatness ($A_V = 5$)

Applications

- Unity gain buffers
- Low gain op amp
- High speed peak detectors
- Video amplifier
- Flash converter driver

Simplified Schematic



*Pins 2 and 7 can also be left disconnected (floating)

**The built-in 150 Ω can be used as feedback resistor for $A_V = 1$. For details see applications section.

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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_S	$\pm 18V$
Power Dissipation, P_D (See Graph)	1.65W
Output Current	125 mA
Non-Inverting Input Voltage Range, V_{CM} (For $V_S \leq +15V$) (Note 1)	$\pm V_S$

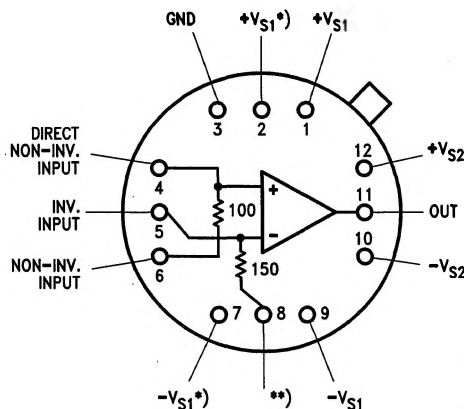
Operating Temperature Range, T_A	
LH4118CG	-25°C to $+85^\circ\text{C}$
LH4118G, LH4118AG	-55°C to $+125^\circ\text{C}$
Storage Temperature Range, T_{STG}	-65°C to $+150^\circ\text{C}$
Maximum Junction Temperature, T_J	175°C
Lead Temperature (Soldering, < 10 sec.)	300°C
ESD Tolerance (Note 2)	650V

DC Electrical Characteristics

Unless otherwise noted, $R_S = 50\Omega$, $T_A = T_C = 25^\circ\text{C}$, $V_S = \pm 15V$ (Notes 3, 4)

Symbol	Parameter	Conditions	LH4118AG			Units (Max Unless Otherwise Noted)
			Typical	Tested Limit (Note 5)	Design Limit (Note 6)	
V_{OS}	Non-Inverting Input Offset Voltage	$V_{IN} = 0V$	± 2	± 2 ± 5		mV
$\frac{\Delta V_{OS}}{\Delta T}$	Offset Voltage Drift		10			$\mu V/^\circ\text{C}$
I_B	Non-Inverting Input Bias Current		± 5	± 25 ± 30		μA
V_O	Output Voltage Swing	$R_L = 500\Omega$	± 13	± 11 ± 10.5		V (Min)
V_O	Output Voltage Swing	$R_L = \infty$	± 14	± 12 ± 11.5		V (Min)
I_O	Output Current Swing	$R_L = 50\Omega$ (Note 7)		± 100		mA (Min)
CMRR	Common Mode Rejection Ratio	$V_{IN} = -11V$ to $+11V$, $V_S = \pm 18V$	54	50		dB (Min)
PSRR	Power Supply Rejection Ratio	$\pm V_S = 9V$ to $15V$ $\Delta V = 6V$	72	62		dB (Min)
I_S	Quiescent Supply Current	$V_{IN} = 0V$	20	25		mA
P_D	Quiescent Power Dissipation	(Note 7)	600	750		mW
C_{IN}	Input Capacitance		1.5			pF

Connection Diagram



Top View

TL/K/9768-2

*Pins 2 and 7 can also be left disconnected (floating)

**The built-in 150Ω can be used as feedback resistor for $A_V = 1$. For details see applications section.

Order Number LH4118G, LH4118AG or LH4118CG
See NS Package Number H12B

DC Electrical CharacteristicsUnless otherwise noted, $R_S = 50\Omega$, $T_A = T_C = 25^\circ\text{C}$, $V_S = \pm 15\text{V}$ (Notes 3, 4)

Symbol	Parameter	Conditions	LH4118G			Units (Max Unless Otherwise Noted)
			Typical	Tested Limit (Note 5)	Design Limit (Note 6)	
V_{OS}	Non-Inverting Input Offset Voltage	$V_{IN} = 0\text{V}$	± 2	± 5		mV
$\frac{\Delta V_{OS}}{\Delta T}$	Offset Voltage Drift		10			$\mu\text{V}/^\circ\text{C}$
I_B	Non-Inverting Input Bias Current		± 5	± 25 ± 30		μA
V_O	Output Voltage Swing	$R_L = 500\Omega$	± 13	± 11 ± 10.5		V (Min)
V_O	Output Voltage Swing	$R_L = \infty$	± 14	± 12 ± 11.5		V (Min)
I_O	Output Current Swing	$R_L = 50\Omega$ (Note 7)		± 100		mA (Min)
CMRR	Common Mode Rejection Ratio	$V_{IN} = -11\text{V}$ to $+11\text{V}$, $V_S = \pm 18\text{V}$	54	50		dB (Min)
PSRR	Power Supply Rejection Ratio	$\pm V_S = 9\text{V}$ to 15V $\Delta V = 6\text{V}$	72	62		dB (Min)
I_S	Quiescent Supply Current	$V_{IN} = 0\text{V}$	20	25		mA
P_D	Quiescent Power Dissipation	(Note 7)	600	750		mW
C_{IN}	Input Capacitance		1.5			pF

DC Electrical CharacteristicsUnless otherwise noted, $R_S = 50\Omega$, $T_A = T_C = 25^\circ\text{C}$, $V_S = \pm 15\text{V}$ (Notes 3, 4)

Symbol	Parameter	Conditions	LH4118CG			Units (Max Unless Otherwise Noted)
			Typical	Tested Limit (Note 5)	Design Limit (Note 6)	
V_{OS}	Non-Inverting Input Offset Voltage	$V_{IN} = 0\text{V}$	± 2	± 5	± 5	mV
$\frac{\Delta V_{OS}}{\Delta T}$	Offset Voltage Drift		10			$\mu\text{V}/^\circ\text{C}$
I_B	Non-Inverting Input Bias Current		± 5	± 25	± 30	μA
V_O	Output Voltage Swing	$R_L = 500\Omega$	± 13	± 11	± 10.5	V
V_O	Output Voltage Swing	$R_L = \infty$	± 14	± 12	± 11.5	V (Min)
I_O	Output Current Swing	$R_L = 50\Omega$ (Note 7)		± 100	± 100	mA
CMRR	Common Mode Rejection Ratio	$V_{IN} = -11\text{V}$ to $+11\text{V}$, $V_S = \pm 18\text{V}$	54	50	50	dB
PSRR	Power Supply Rejection Ratio	$\pm V_S = 9\text{V}$ to 15V $\Delta V = 6\text{V}$	72	62	62	dB
I_S	Quiescent Supply Current	$V_{IN} = 0\text{V}$	20	25	25	mA
P_D	Quiescent Power Dissipation	(Note 7)	600	750	750	mW
C_{IN}	Input Capacitance		1.5			pF

AC Electrical Characteristics

Unless otherwise noted, $A_v = +2$, $R_S = 50\Omega$, $R_L = 100\Omega$, $V_S = \pm 15V$, $T_A = 25^\circ C$

Symbol	Parameter	Conditions	LH4118CG, LH4118AG and LH4118G			Units (Max Unless Otherwise Noted)
			Typical	Tested Limit	Design Limit	
SSBW –3 dB	Small Signal Bandwidth	$V_{OUT} = 0.2 V_{P-P}$	250	200		MHz (Min)
PBW –3 dB	Power Bandwidth	$V_{OUT} = 10 V_{P-P}$	68	55		MHz (Min)
GF	Gain Flatness	$V_{OUT} =$ $0.2 V_{P-P}$	0.5 MHz, –50 MHz	± 0.3		dB (Max)
			0.5 MHz, –100 MHz	–1.0		
SR	Slew Rate LH4118AG LH4118G LH4118CG	$V_{OUT} = 15 V_{P-P}$ 20%–80%		2400 2000 1800		V/ μ S (Min)
t_r	Rise Time	$V_{OUT} = 10 V_{P-P}$ 10%–90%	2.5			ns
V_{GC}	–1 dB Gain Compression	$f = 50$ MHz	23.5			dBm
e_n	Input Noise Voltage	$A_v = 5$, $R_S = 50\Omega$, $f = 10$ MHz	1.3			nV/ $\sqrt{Hz}$
HD ₂	Second Harmonic Distortion	$V_{OC} = 1.27 V_{P-P}$ $F_C = 14$ MHz	–58			dBc
HD ₃	Third Harmonic Distortion	$V_{OC} = 1.27 V_{P-P}$ $F_C = 14$ MHz	–40			dBc
t_s	Settling Time	$A_v = -1$ $V_{IN} = +5 V_{P-P}$ to 0.1%	15			ns
LVBW –3 dB	Low Supply Voltage Bandwidth	$V_{OUT} = 0.2 V_{P-P}$ $V_S = \pm 5V$	230			MHz
LVSR	Low Supply Voltage Slew Rate	$V_S = \pm 5V$, $V_{OUT} = 5 V_{P-P}$ 20%–80%	1400			V/ μ s
DG	Differential Gain	$V_{IN} = \pm 4 V_{DC}$ $0.4 V_{P-P}$ AC $f = 4$ MHz	<0.01			dB
PL	Phase Linearity	$V_{IN} = \pm 4 V_{DC}$ $0.4 V_{P-P}$ AC, $f = 4$ MHz	<0.1			DEG

Note 1: The input signal should be within the supply rails. Also, the input signal as well as the output signal should not be more than 30V from any supply voltage.

Note 2: The average voltage that the weakest pin combinations can withstand and still conform to the datasheet limits. The test circuit used consists of the human body model of 100 pF in series with 1500 Ω .

Note 3: Boldface limits are guaranteed over full temperature range. Operating ambient temperature range of LH4118CG is –25°C to +85°C, for LH4118G and LH4118AG it is –55°C to 125°C.

Note 4: Specifications are at 25°C junction temperature due to requirements of high speed automatic testing. Actual values at operating temperature will exceed value at $T_J = 25^\circ C$.

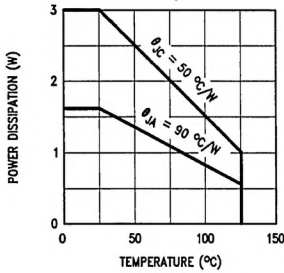
Note 5: Tested limits are guaranteed and 100% production tested.

Note 6: Design limits are guaranteed (but not production tested) over the indicated temperature or temperature range. These limits are not used to calculate outgoing quality level.

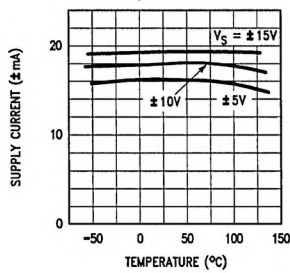
Note 7: When the LH4118 is operated at elevated temperature (such as 125°C), some form of heat sinking or forced air cooling is required. The quiescent power with $V_S = \pm 15V$ is 750 mW, whereas the package can only handle 550 mW without a heatsink at 125°C.

Typical Performance Characteristics

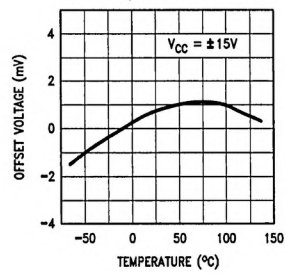
Power Dissipation



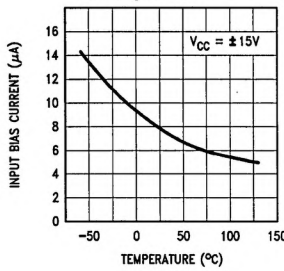
Supply Current vs Temperature



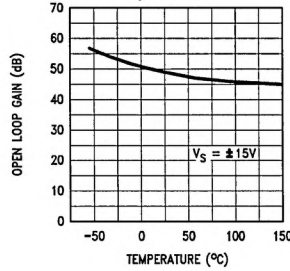
Offset Voltage vs Temperature



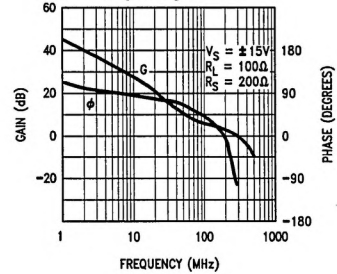
Input Bias Current vs Temperature



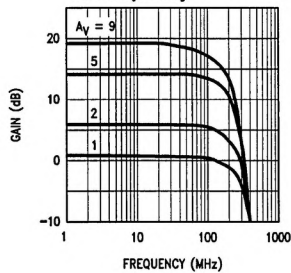
Open Loop Gain vs Temperature



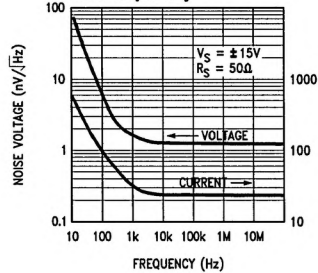
Inverting Open Loop Gain and Phase vs Frequency



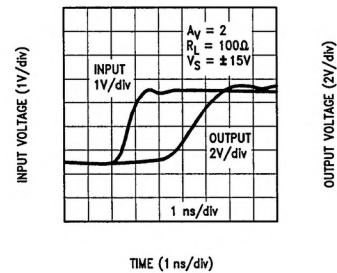
Non-Inverting Closed Loop Gain vs Frequency



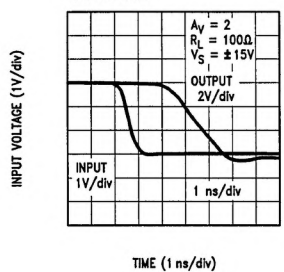
Input Noise vs Frequency



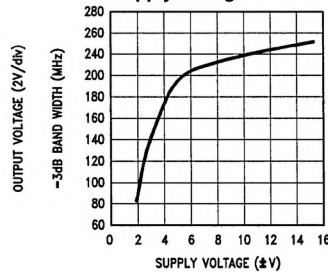
Rise Time



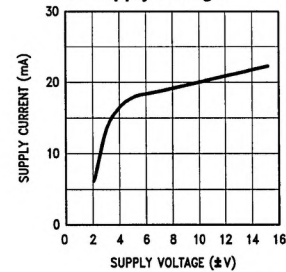
Fall Time



Bandwidth vs Supply Voltage



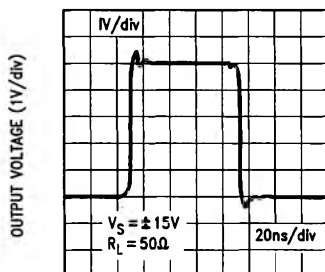
Supply Current vs Supply Voltage



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Typical Performance Characteristics (Continued)

Pulse Response



TIME (20 ns/div)

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Applications Information

LAYOUT

Breadboards should have a solid ground plane and short point-to-point wiring. Do not use wirewrap boards or techniques. PC boards should have short connections and as much ground plane as possible.

The inputs (Pins 4, 5 & 6) should have low capacitance and, therefore, the ground plane should be taken out around these pins. The body of RG should be close to Pin 5 for the same reason.

It is best to have a layout without sockets, but sockets with short pins and receptacles do not degrade the performance much.

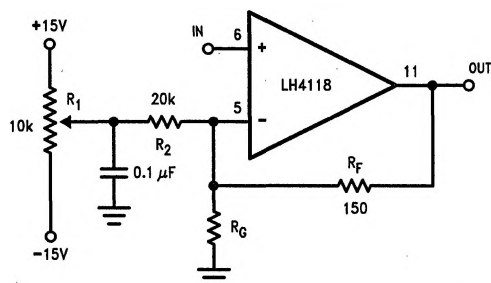
Input and output should be led by coax or microstrip if the distances are more than a few inches to avoid impedance shifts and resulting reflections.

Power supplies need to be bypassed with 0.01 μF to 0.1 μF as close as 0.15" to the pins and additional 1 μF tantalum a maximum 1" distant. Please make sure that the return current from the ground end of R_L does not flow across the input: the grounding point of R_L should be close to the grounding points of the power supply bypass capacitors. On the LH4118, this comes almost natural because of the layout of the pins.

The direct non-inverting input on pin 4, if used, should not see impedances of less than 100 Ω .

The built-in feedback resistor (pin 8) is limited to a maximum dissipation of 150 mW. It can be used for unity gain and for higher gains at lower amplitudes.

Input-to-Output Offset Zero Adjust



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This circuit lets the V_{OS} between non-inverting input (pin 6) and output (pin 11) be adjusted. For $R_G = 15\Omega$ the range of adjustment is ± 11 mV, for higher R_G proportionately more. For higher R_G it is recommended to increase R_2 to decrease the range and make trimming less sensitive.

There is also an offset between inverting and non-inverting input which cannot be trimmed out.

Typical Applications

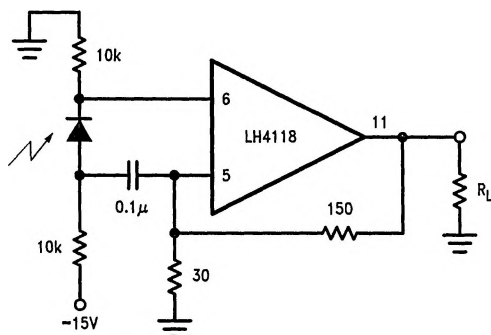


FIGURE 1. Bootstrapped Fiber Optic Receiver

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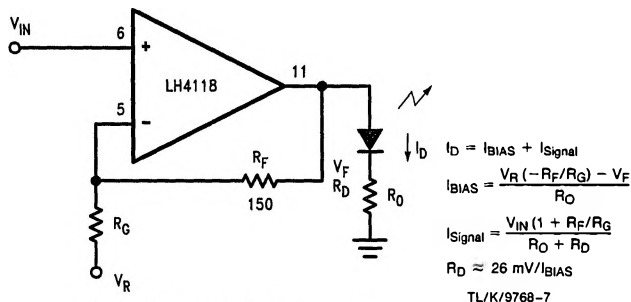


FIGURE 2. Fiber Optic Transmitter

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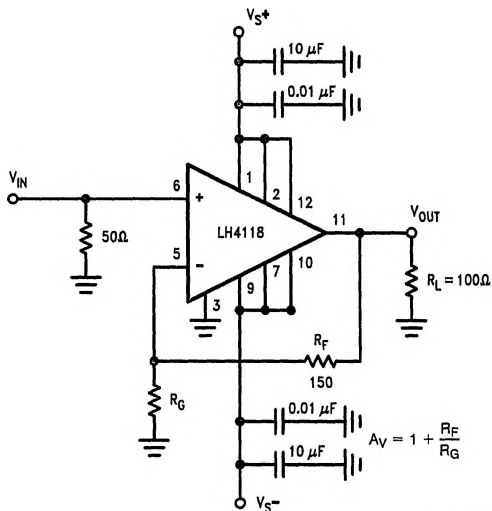
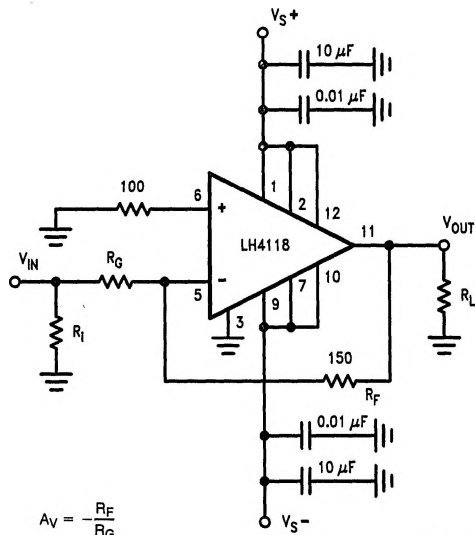


FIGURE 3. Non-Inverting Gain Circuit

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RI is selected so that $R_I \parallel R_G$ matches the line impedance (e.g., 50Ω)

FIGURE 4. Inverting Gain Circuit

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Typical Applications (Continued)

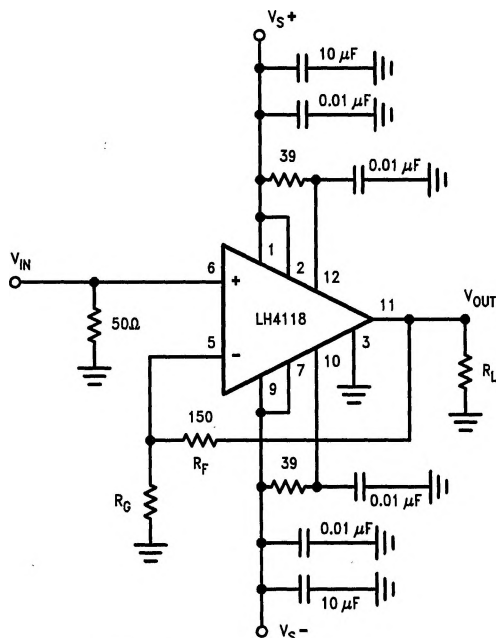
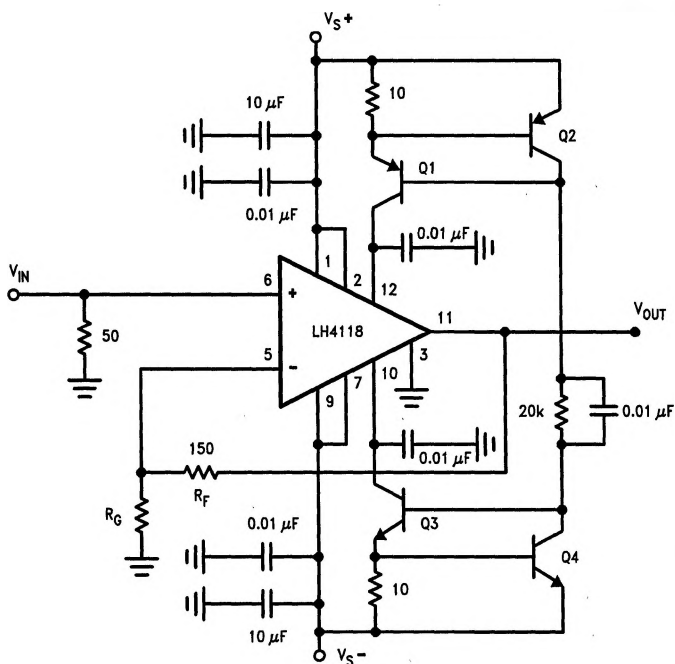


FIGURE 5. Current Limiting Using Resistor

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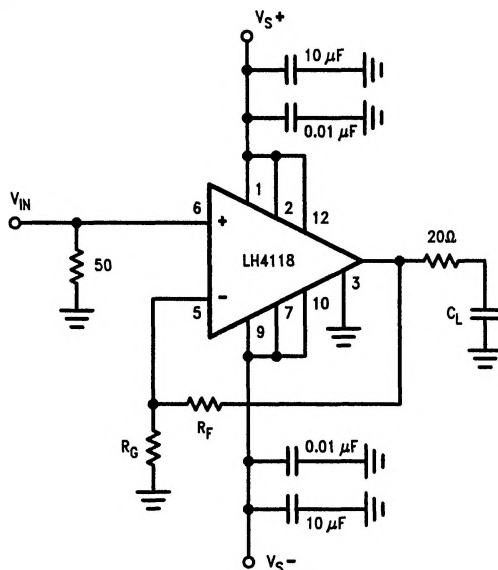
Q1 = Q2 = 2N2905
Q3 = Q4 = 2N2219

TL/K/9768-11

The current cutoff is set to $I = \frac{V_{BE}}{R} = \frac{600 \text{ mV}}{10\Omega} = 60 \text{ mA}$. Higher current peaks are sustained by the $0.01 \mu\text{F}$ Capacitors.

FIGURE 6. Current Limiting Using Transistor Current Source

Typical Applications (Continued)

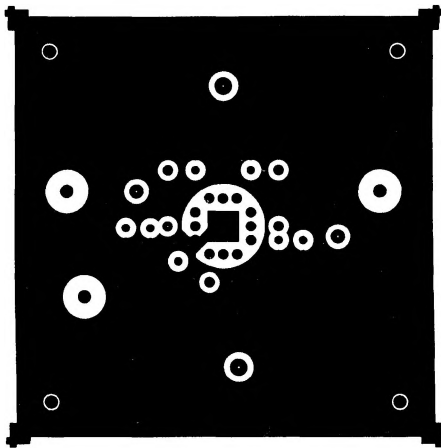


TL/K/9768-12

A series resistor between 5 Ω and 50 Ω helps to stabilize capacitive loads. There is, however, a corresponding drop in bandwidth.

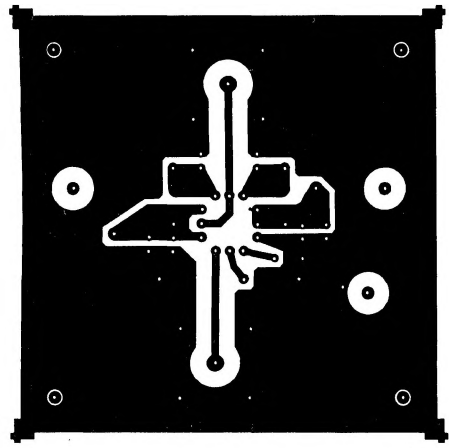
Evaluation Board

(3" x 3", not to scale)



TL/K/9768-13

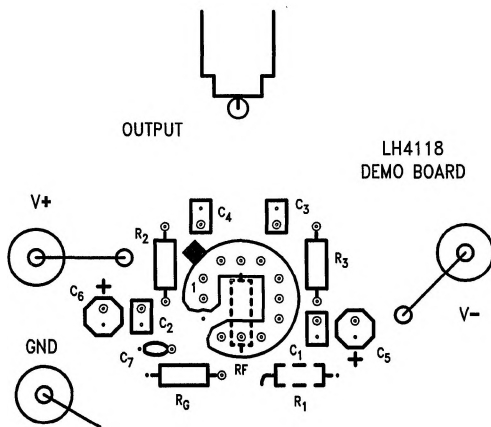
Top



TL/K/9768-14

Bottom

Components



LH4118
DEMO BOARD

OUTPUT

INPUT



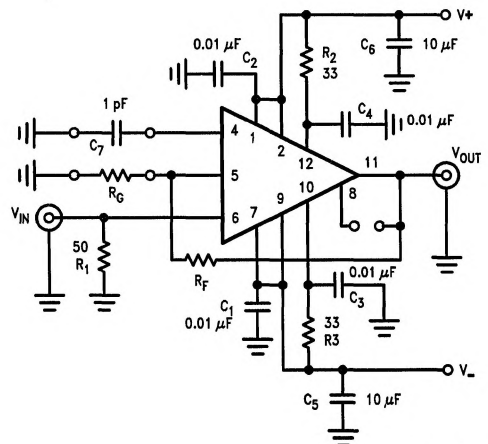
Top View

TL/K/9768-15

Input and output connections are made through BNC connectors. When the indicated cut-outs are made, the connectors can be placed in-line. As an alternative, Amphenol No. 31-4758 connectors can be used soldered upright into the board.

R1 is the termination resistor of the input line. It is mounted on the bottom of the board, with one side soldered flat to the center of the input strip-line.

Schematic Diagram



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The LH4118 can be soldered directly into the board or Hole-tight pins can be used (Augat part No. 8134-HC-5P2). These pins need plated through holes with a finished inner diameter of 41 ± 2 Mil. For $A_V = 1$ the built-in R_F (150 ohm) can be utilized by bridging the trace between pins 8 and 11. In this case no external R_F should be used.