Model SR554
Transformer Preamplifier

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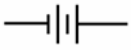
Revision 1.2 (07/2004)

SR554 SPECIFICATIONS

Inputs	Single ended or differential
Input Impedance	0.5 Ω
Maximum Inputs	Transformer and Buffer: 14.0 mV RMS (±20 mV peak) Transformer only: 350 mV RMS (±0.5 V peak)
Common Mode	Range: ± 100 VDC Rejection: 140 dB @ 100 Hz
Isolation	> 40dB DC to 500 MHz
Input Noise (Transformer and Buffer)	120 pV/√Hz @ 10 Hz (typical) 100 pV/√Hz @ 100 Hz 100 pV/√Hz @ 1000 Hz (see noise contours, pg. 5)
Gain	Transformer and Buffer: 500 (nominal) Transformer only: 100 (nominal) See Amplitude-Frequency Response Curve (pg 6).
Gain Accuracy	5% (with fixed source resistance)
Gain Stability	100 ppm/ °C
Outputs	Single ended or differential
Output Impedance	Transformer and Buffer: < 1.0 Ω Transformer only: > 5000 Ω
Maximum Output	Transformer and Buffer: 7.1 V RMS (10 Volts peak) Transformer only: 35.3 V RMS (50 Volts peak)
Power	Provided by any SRS lock-in amplifier via the supplied connector cable or from a ± 20 volts DC @ 100 mA source.
Mechanical	2.9" X 3.8" X 7.5" (HxWxL), 4 lb.
Warranty	One year parts and labor on materials and workmanship.

Symbols you may find on SRS products.

Symbol	Description
	Alternating current
	Caution - risk of electric shock
	Frame or chassis terminal
	Caution - refer to accompanying documents
	Earth (ground) terminal
	Battery
	Fuse
	On (supply)
	Off (supply)

OPERATION

The SR554 Transformer Preamplifier is designed to be used with all SRS Lock-in amplifiers. It can reduce input noise of a lock-in amplifier dramatically (as low as 100 pV/√Hz) and extends the lock-in's full scale sensitivity (without expand). It also nearly eliminates noise radiated back from the lock-in amplifier to the users experiment. When used as a remote preamplifier, the SR554 can eliminate the effects of noise pickup on long signal cables. The SR554 transformer is designed to be used with its internal buffer, but the buffer may be bypassed for transformer only operation. When used as a simple transformer, no power connection is required.

CONNECTING THE SR554

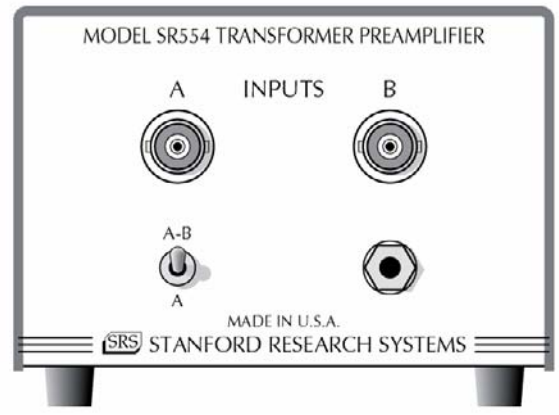
When the transformer and buffer are used together, power is supplied to the SR554 via the 9 pin connector and cable. This cable mates with all SRS lock-in amplifiers through the rear panel connector. To use the SR554 without an SRS lock-in, the user must provide their own ±20 VDC (100 mA) source. Always connect the power cable to the SR554 while the lock-in power is off. Attach one end of the cable to the connector on the rear of the SR554, and connect the other end to the PRE-AMP connector on the rear of the lock-in. If a longer cable is required, any standard 9 pin cable will suffice since all connections are straight through. When the lock-in power is on, the POWER indicator on the SR554 will light.

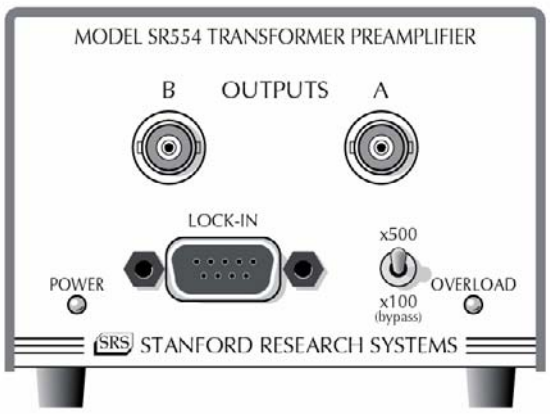
The SR554 output switch selects between buffered mode with a gain of 500, (transformer and buffer) or bypassed mode with a gain of 100 (transformer alone). In the buffered mode, the transformer secondary goes into a low noise buffer which drives the output cable. This is to reduce loading due to the transformer output impedance (about 5 kΩ) and cable capacitance (10's of pf). If the user prefers not to use the buffer or if power isn't available for the preamp, then the SR554 can be used in the bypassed mode. In the bypassed mode, the output impedance of the pre-amp is 5 kΩ and care must be taken to avoid loading the output with too much cable capacitance. Power should not be connected to the SR554 when used in the bypass mode.

INPUT CONNECTION

Signals into the SR554 can be connected either single ended through the (A) input, or differentially through the (A-B) inputs. In the single ended configuration the shield and center conductor of the (A) input are connected to the transformer. For differential connection, the shields of the input BNC's are connected to the SR554 case and the (A) and (B) center conductors connect to the transformer.

The input impedance is a combination of 0.5 Ω and 0.5 H (in series) in parallel with





1.6 μF. The real portion of the input impedance (0.5 Ω) determines the noise performance. See page 7 for detailed information on input impedance.

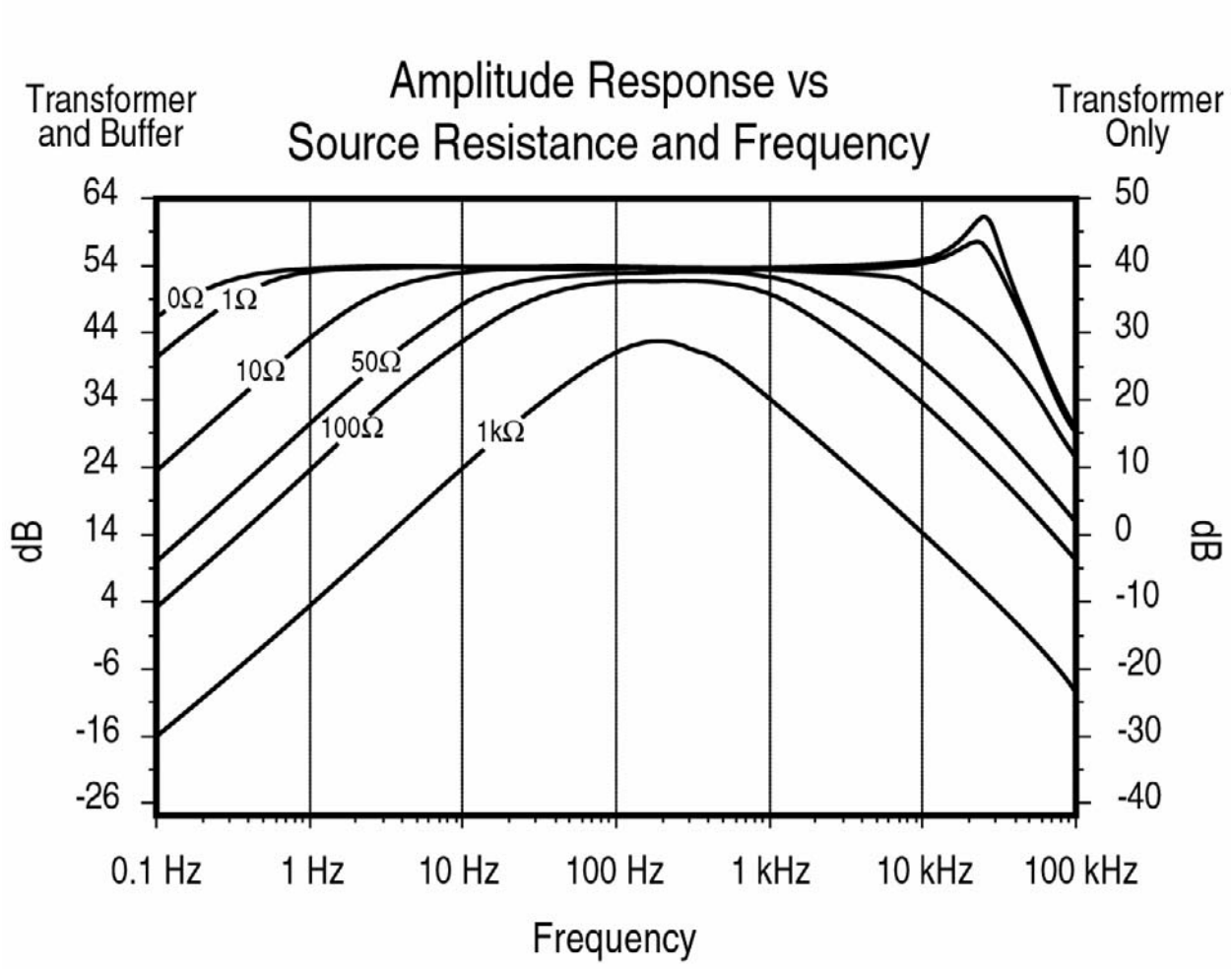
The input can be floated up to ±100 VDC with respect to the chassis. The maximum AC input before overload is 14 mV RMS (±20 mV peak) when the unit is in the buffered mode. In either mode, the input is clamped at about 350 mV RMS (±0.5 V peak). Care should be taken when the unit is used in the bypassed mode, since a ±0.5 V peak input becomes ±50 V at the output.

In the buffered mode, the OVERLOAD indicator will light when the preamplifier overloads. An overload that occur after the preamplifier will be indicated by the lock-in amplifier's overload indicator. The SR554's overload indicator is only functional when the unit is in the buffered mode. If the unit is operated in the bypassed mode and power is applied, the overload LED may light even when the unit is not overloaded. This does not indicate an overload, but is due to leakage current of the buffer amplifier and its protection circuitry. To avoid this, power should not be connected when the unit is used in the bypassed mode.

OUTPUT CONNECTION

For single ended operation the (A) Output of the SR554 should be connected to the (A) Input of the lock-in amplifier. The center conductor carries the signal and the shield is ground. For most applications, this single connection will be adequate.

For situations with potential noise pick-up on the cable, it may be better to operate in

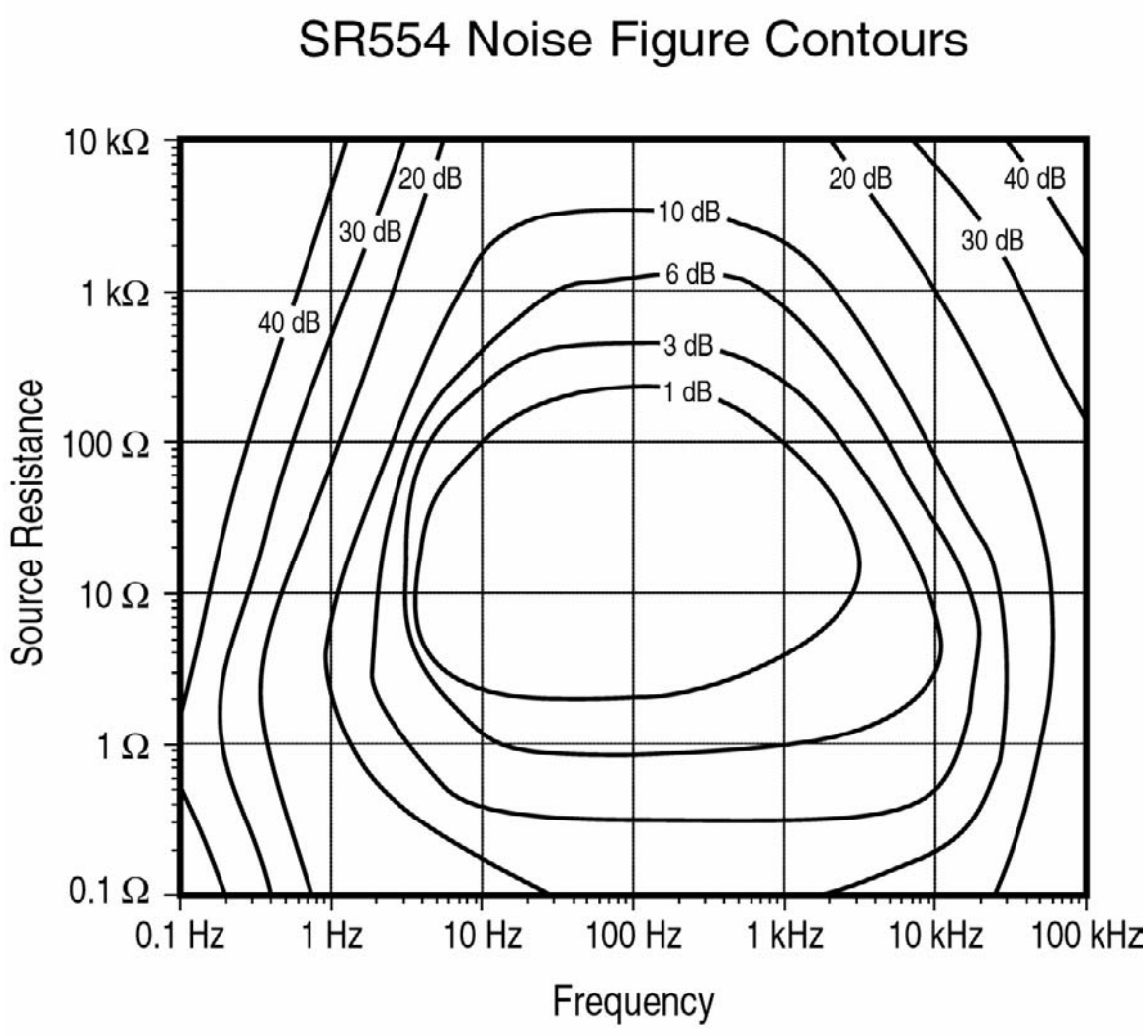


the differential mode. In differential operation the (A) and (B) center conductors carry the signal and shielded preamp ground, and the shields are tied to the SR554 chassis. The (A) and (B) cables should be twisted together to prevent inductive pick-up.

For most experiments it is preferable to use the SR554 in the buffered mode. If the preamplifier is used in the bypass mode, care must be taken to not load the output. The output resistance of the transformer is at least 5 kΩ (for a 0 Ω source) and is typically 10,000 times the input resistance. Therefore, a 50 Ω source impedance will become 500 kΩ. If the instrument that the SR554 is connected to has an input impedance of 1 MΩ, 1/3 of the signal is lost. Any significant cable capacitance will create a low-pass filter with this output resistance as well, so short cables should always be used.

GAIN OF SR554

The actual gain of the SR554 is a function of the source impedance, frequency and the set gain. In the bypass mode (x100), the gain will be affected by loading on the output. The gain is fairly flat over a range of input impedances (<10 Ω) and frequencies (5 Hz-10 kHz). The actual gain can be determined from the amplitude-frequency response curves on page 4. The plot assumes operating the SR554 in the buffered mode or with no loading on the output in the bypassed mode.



EXTRA LOW NOISE MEASUREMENTS

When making extremely low noise measurements, it is a good practice to connect the grounding plug of the SR554 to a ground point near the experiment. If a good ground is not available near the experiment, connect a wire from the lock-in chassis (using a lug under one of the chassis screws) to the grounding lug of the SR554.

NOISE FIGURE

The noise figure describes the noise contribution of an amplifier in a measurement when compared to an ideal amplifier.

The expression:

$$NF = 20 \log\left[\frac{N}{A^{\star}\, en_{rs}}\right]$$

where *N* is the measured noise, *A* is the pre-amp gain and en_{rs} is the Johnson noise of the source impedance, describes the noise figure contours shown below. The optimum operating frequency can be determined from this graph.

USING THE SR554 WITH SRS LOCK-INS

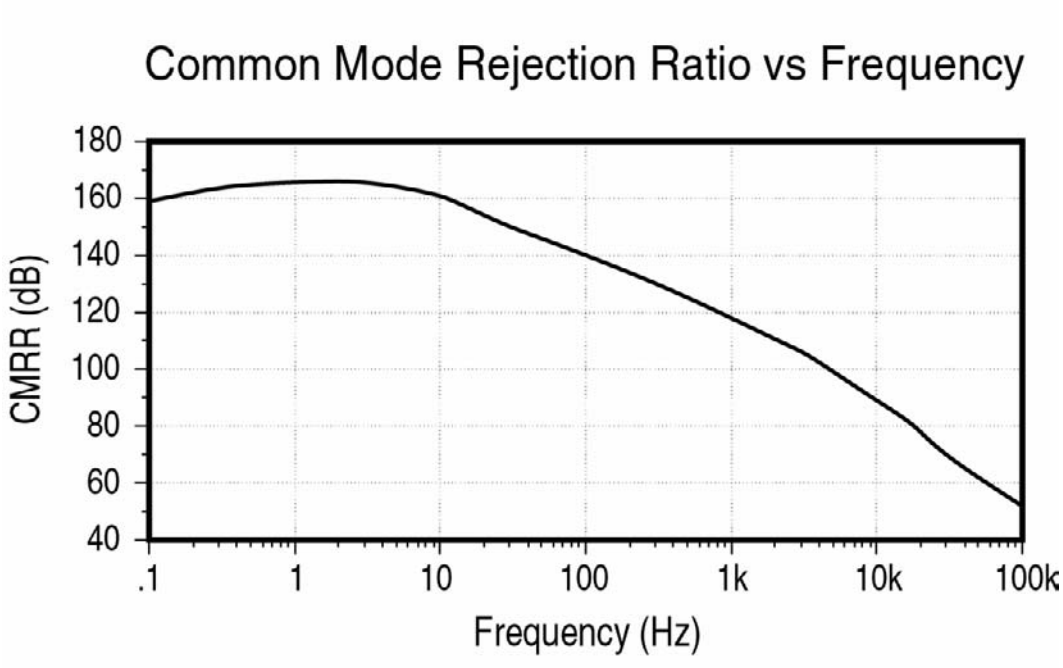
The SR554 is not sensed through the 9 pin cable by SRS lock-in amplifiers. Therefore the lock-in does NOT compensate for the gain of the preamp. Measurements made using the preamp must be divided by the gain of the SR554. The actual gain can be obtained from the amplitude response curves on page 4.

USING THE SR554 WITH THE SR810/830/850

For typical measurements the lock-in input should be set to AC coupled, with the shield grounded. For low frequency measurements (<1Hz), set the lock-in to DC coupled, with the shield grounded, since the SR554 can sense signals below the lock-in's AC coupling frequency (0.16 Hz).

USING THE SR554 WITH THE SR510/530

The SR510/530 is AC coupled from 0.5 Hz to 100 kHz. Measurements below 0.5 Hz are not recommended with the SR510/530.



USING THE SR554 WITHOUT AN SRS LOCK-IN

The SR554 can be powered with an external power supply. Power is applied through the 9 pin connector as described below.

PIN	VOLTAGE	CURRENT
1	+20 V	100 mA
6	-20 V	100 mA
7,8	Ground	

Both voltages are required. Pins 7 and 8 should be tied together and grounded. All other pins should be left open.

COMMON MODE REJECTION RATIO

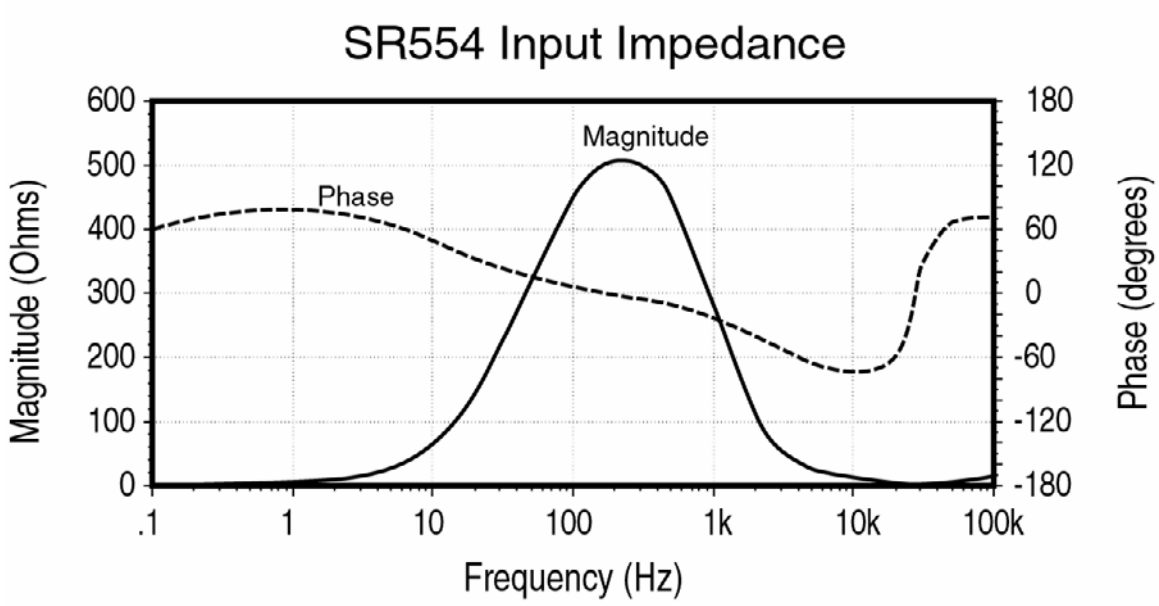
The SR554 has an extremely high CMRR at low frequencies (up to 160 dB below 10 Hz). It drops off at higher frequencies due to capacitive coupling between the primary and secondary windings and reduced signal gain. See the graph below for the relationship between CMRR and frequency.

RADIATED NOISE

The SR554 reduces radiated noise from the lock- in amplifier's input by 40 dB (100x) over most frequencies (DC to 500 MHz). To minimize radiated noise, a thick (low impedance) wire should be connected from the ground plug to a quiet ground point. If a ground is not available near the experiment, connect a wire to the lock-in using a lug under one of the chassis screws.

INPUT IMPEDANCE

The input impedance of the SR554 appears as a combination of 0.5 Ω and 0.5 H (in series) in parallel with 1.6 μF and several parasitic impedances. The transformer primary has a DC resistance of 0.2 Ω and a primary inductance of 0.5 H. The secondary has a DC resistance of 3 kΩ and a capacitance of about 160 pF. When the secondary impedance is converted over to the primary side of the transformer by the turns ratio (1:100), the 0.5 Ω, 0.5 H and 1.6 μF values are obtained. The actual values of the magnitude and phase of the input impedance is shown in the graph below.



PERFORMANCE TESTS

Performance tests are designed to verify that the unit is performing within the specifications.

Necessary Equipment:

1. **Lock-In Amplifier**
   Freq Range 0.1 Hz - 100 kHz
   Output Ampl 4 mV rms - 1 Vrms
   Output Z 50 Ω
   Recommended SRS SR850/830/810

2. **50 ΩTerminator**

3. **50 Ω, 20 dB Attenuator**

The instructions here apply to SRS DSP lock-ins (SR850/830/810). Other lock-in amplifiers may be used. However they will require substantially longer time constants to arrive at accurate measurements.

1) Connect the 9-pin power cable from the rear of the lock-in amplifier to the SR554. Connect the 20 dB attenuator to the lock-in reference output and a BNC cable from that to the SR554 (A) input. Connect another BNC cable from the SR554's (A) output to the lock-in's (A) input. Set SR554 to buffered mode (X500), (A) input.

2) Power on the lock-in in the default condition. (SR810/830 Power on Setup, SR850 Power on Bksp) This places the lock-in in a known state. The power LED of the SR554 should light.

3) Set the input to DC coupled, grounded shield. Set the time constant to 300 ms (1 s for 1 Hz measurement), 12 dB/oct filter and turn on synchronous filtering (if available). Set the display type to magnitude (R) and the reference sinewave amplitude to 10 mV rms.

4) For each frequency, the following amplitude should be observed, ± 5%.

Frequency	Amplitude
1.0 Hz	31 mV
10 Hz	252 mV
100 Hz	438 mV
200 Hz	442 mV
500 Hz	439 mV
1 kHz	414 mV
10 kHz	96 mV
100 kHz	11 mV

5) Disconnect the lock-in reference from the SR554 input. Connect the 50 Ω terminator to the SR554 (A) input.

6) Set the lock-in to measure noise.

7) For each frequency and time constant, the following rms noise voltage should be observed (±10%). Set the lock-in sensitivity to about 5 times the expected reading and allow it to settle (10-20 time constants) before making readings.

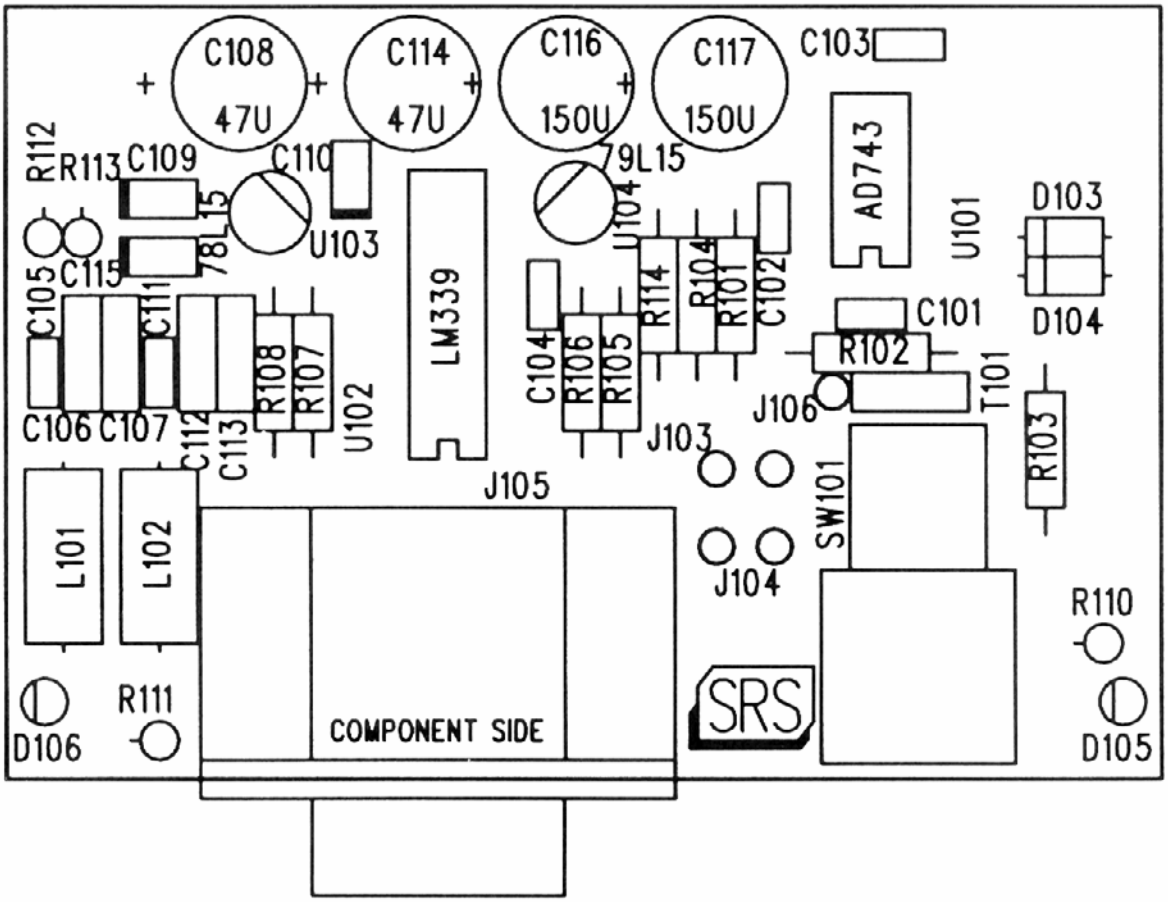
Frequency	Time Constant	Noise Voltage
1.0 Hz	3.0 s	480 nV
10 Hz	1.0 s	260 nV
100 Hz	0.1 s	460 nV
200 Hz	0.1 s	460 nV
500 Hz	0.1 s	460 nV
1 kHz	0.03 s	420 nV
10 kHz	0.03 s	120 nV
100 kHz	0.03 s	60 nV

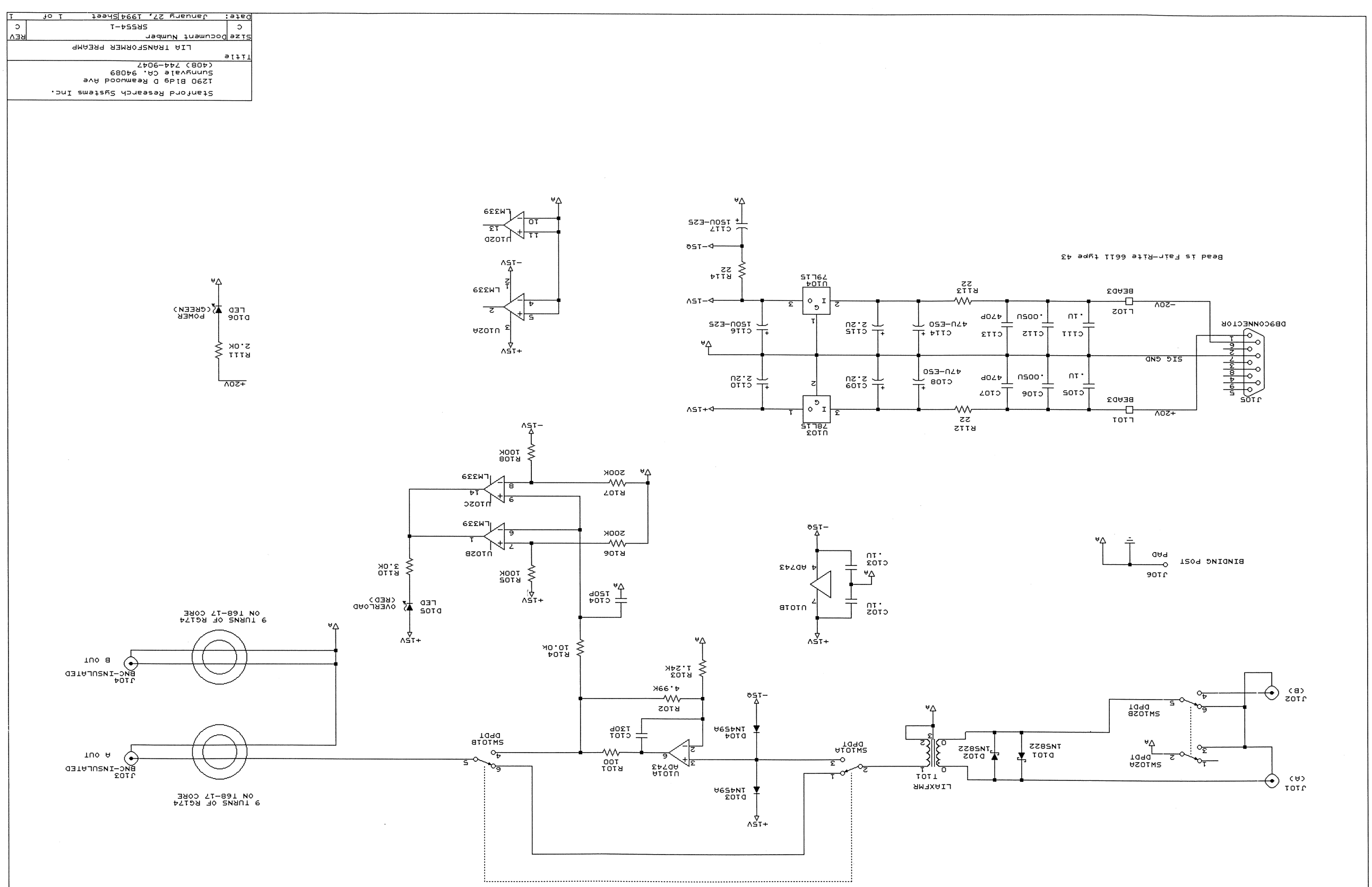
Part List

Ref.	SRS part	Value	Description
C 101	5-00254-501	130P	Capacitor, Ceramic Disc, 50V, 10%, SL
C 102	5-00023-529	.1U	Cap, Monolythic Ceramic, 50V, 20%, Z5U
C 103	5-00023-529	.1U	Cap, Monolythic Ceramic, 50V, 20%, Z5U
C 104	5-00005-501	150P	Capacitor, Ceramic Disc, 50V, 10%, SL
C 105	5-00023-529	.1U	Cap, Monolythic Ceramic, 50V, 20%, Z5U
C 106	5-00312-503	.005U	Capacitor, Ceramic Disc, 50V, 20%, Z5U
C 107	5-00016-501	470P	Capacitor, Ceramic Disc, 50V, 10%, SL
C 108	5-00044-509	47U	Capacitor, Electrolytic, 50V, 20%, Rad
C 109	5-00100-517	2.2U	Capacitor, Tantalum, 35V, 20%, Rad
C 110	5-00100-517	2.2U	Capacitor, Tantalum, 35V, 20%, Rad
C 111	5-00023-529	.1U	Cap, Monolythic Ceramic, 50V, 20%, Z5U
C 112	5-00312-503	.005U	Capacitor, Ceramic Disc, 50V, 20%, Z5U
C 113	5-00016-501	470P	Capacitor, Ceramic Disc, 50V, 10%, SL
C 114	5-00044-509	47U	Capacitor, Electrolytic, 50V, 20%, Rad
C 115	5-00100-517	2.2U	Capacitor, Tantalum, 35V, 20%, Rad
C 116	5-00281-521	220U	Capacitor, Electrolytic, 25V, 20%, Rad
C 117	5-00281-521	220U	Capacitor, Electrolytic, 25V, 20%, Rad
D 101	3-00226-301	1N5822	Diode
D 102	3-00226-301	1N5822	Diode
D 103	3-00403-301	1N459A	Diode
D 104	3-00403-301	1N459A	Diode
D 105	3-00011-303	RED	LED, T1 Package
D 106	3-00010-303	GREEN	LED, T1 Package
J 101	1-00003-120	BNC	Connector, BNC
J 102	1-00003-120	BNC	Connector, BNC
J 103	1-00003-120	BNC	Connector, BNC
J 104	1-00003-120	BNC	Connector, BNC
J 104	1-00014-160	9 PIN D	Connector, D-Sub, Right Angle PC, Female
J 109	1-00229-102	BINDING	Binding Post
L 101	6-00174-630	6611 TYPE 43	Ferrite Beads
L 102	6-00174-630	6611 TYPE 43	Ferrite Beads
PC1	7-00613-701	SR554 PREAMP	Printed Circuit Board
R 101	4-00141-407	100	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 102	4-00188-407	4.99K	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 103	4-00134-407	1.24K	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 104	4-00138-407	10.0K	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 105	4-00142-407	100K	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 106	4-00166-407	200K	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 107	4-00166-407	200K	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 108	4-00142-407	100K	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 110	4-00063-401	3.0K	Resistor, Carbon Film, 1/4W, 5%
R 111	4-00045-401	2.0K	Resistor, Carbon Film, 1/4W, 5%
R 112	4-00056-401	22	Resistor, Carbon Film, 1/4W, 5%
R 113	4-00056-401	22	Resistor, Carbon Film, 1/4W, 5%
R 114	4-00056-401	22	Resistor, Carbon Film, 1/4W, 5%
SW101	2-00022-217	DPDT	Switch, On-None-On, Toggle, Right Angle
SW102	2-00027-214	DPDT	Switch, Miniature Bat Toggle
T 101	6-00169-610	SR554	Transformer
T 102	6-00173-614	T68-17	Iron Powder Core
T 103	6-00173-614	T68-17	Iron Powder Core
U 101	3-00535-340	AD743	Integrated Circuit (Thru-hole Pkg)
U 102	3-00193-340	LM339	Integrated Circuit (Thru-hole Pkg)
U 103	3-00118-325	78L15	Transistor, TO-92 Package
U 104	3-00124-325	79L15	Transistor, TO-92 Package
Z 0	0-00025-005	3/8"	Lugs

Part List

Ref.	SRS part	Value	Description
Z 0	0-00043-011	4-40 KEP	Nut, Kep
Z 0	0-00079-031	4-40X3/16 M/F	Standoff
Z 0	0-00089-033	4"	Tie
Z 0	0-00128-053	4" #24	Wire #24 UL1007 Strip 1/4x1/4 Tin
Z 0	0-00150-026	4-40X1/4PF	Screw, Black, All Types
Z 0	0-00187-021	4-40X1/4PP	Screw, Panhead Phillips
Z 0	0-00208-020	4-40X3/8PF	Screw, Flathead Phillips
Z 0	0-00209-021	4-40X3/8PP	Screw, Panhead Phillips
Z 0	0-00221-000	SR440FOOT	Hardware, Misc.
Z 0	0-00263-052	3" #22	Wire #22 UL1007
Z 0	0-00266-052	8-1/2" #22	BLK Wire #22 UL1007
Z 0	0-00304-043	7/8X3/8X1/16	Washer, nylon
Z 0	0-00386-003	SOLDR SLV RG174	Termination
Z 0	0-00440-052	2-1/2" #22 RED	Wire #22 UL1007
Z 0	7-00604-720	SR554-1	Fabricated Part
Z 0	7-00605-720	SR554-2	Fabricated Part
Z 0	7-00606-720	SR554-3	Fabricated Part
Z 0	7-00607-709	SR554	Lexan Overlay
Z 0	9-00267-917	GENERIC	Product Labels





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