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MODEL SR540

OPTICAL CHOPPER



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MODEL SR540

OPTICAL CHOPPER

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Rev. 2.6 (06/2009)

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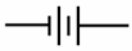
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Symbols you may find on SRS products.

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)

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SPECIFICATIONS

Chop Frequency	4 Hz to 400 Hz with 6 slot blade. 400 Hz to 3.7 kHz with 30 slot blade.
Frequency Stability	250 ppm/°C typical.
Long Term Frequency Drift	< 2%, 100 Hz < f < 3700 Hz
Phase Jitter	0.2° rms from 50 Hz to 400 Hz. 0.5° rms from 400 Hz to 3.7 kHz.
Frequency Display	4 digit, 1 Hz resolution, 1 Hz accuracy.
Frequency Control	10 turn pot with 3 ranges: 4 Hz to 40 Hz 40 Hz to 400 Hz 400 Hz to 3.7 kHz
VCO	0 to 10 VDC. Control voltage overrides frequency dial.

Reference Modes

Switch	Left BNC	Right BNC
up	f_{inner}	f
middle	5 x f	f
down	$f + f_{inner}$	$f - f_{inner}$

Dimensions	Controller 7.7" x 5.1" x 1.8" Chopper Head 2.8" x 2.1" x 1.0" Blade Diameter 4.00"
Power	100 / 120 / 220 / 240 VAC 50 / 60 Hz 12 Watts
Warranty	Electronics - One year parts and labor on materials and workmanship. Chopper Motor - Ninety days parts and labor on materials and workmanship.

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SAFETY AND PREPARATION

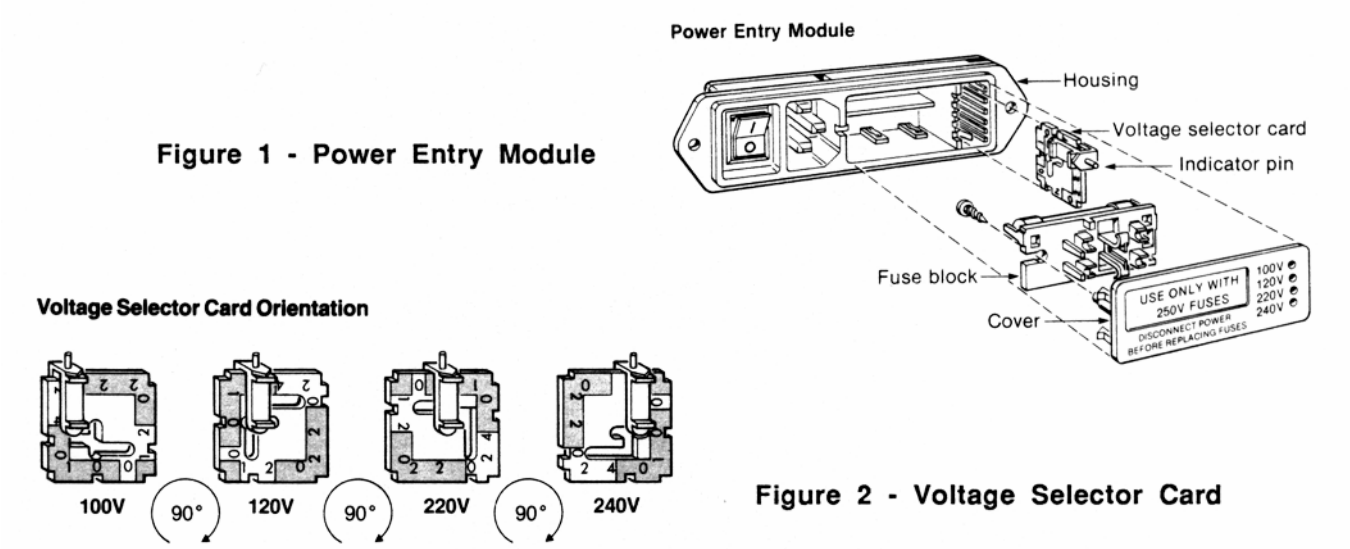


Figure 1 - Power Entry Module

Figure 2 - Voltage Selector Card

********** CAUTION **********

This instrument may be damaged if operated with the LINE VOLTAGE SELECTOR set for the wrong ac input-source voltage or if the wrong fuse is installed.

LINE VOLTAGE SELECTION

The SR540 operates from a 100V, 120V, 220V, or 240V nominal ac power source having a line frequency of 50 or 60 Hz. Before connecting the power cord to a power source, verify that the LINE VOLTAGE SELECTOR card, located in the rear panel fuse holder, is set so that the correct ac input voltage value is visible (figure 1).

To Change Voltage Selected: Open the cover on the power entry module using a small screwdriver; pull the voltage selector card straight out using long-nose pliers; orient selector card so that the desired voltage is readable at the bottom; orient the indicator pin to point up when desired voltage is readable at the bottom (figure 2); insert voltage selector card into housing, printed side facing left, and edge containing desired voltage first; replace cover and verify that the indicator pin shows the desired voltage.

LINE FUSE

Verify that the correct line fuse is installed before connecting the line cord. For 100V and 120V, use a 1/4 Amp fuse and for 220V and 240V, use a 1/8 Amp fuse.

LINE CORD

This instrument has a detachable, three-wire power cord with a three-contact plug for connection to both the power source and protective ground. The protective ground contact connects to the accessible metal parts of the instrument. To prevent electrical shock, always use a power source outlet that has a properly grounded protective-ground contact.

OPERATE ONLY WITH COVERS IN PLACE

To avoid personal injury, do not remove the product covers or panels. Do not operate the product without all covers and panels in place.

KEEP HANDS CLEAR OF CHOPPER BLADE

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Quick Start Instructions

1. Make sure the correct line voltage is selected, the correct fuse is installed, and the power switch is off.

2. Connect the chopper head to the controller with the supplied coiled cord.

3. Mount the 30 slot wheel for 400 Hz to 3.7 kHz or the 6 slot wheel for 4 Hz to 400 Hz, and set the MAX FREQ/SLOT switch on the front panel for the desired frequency range.

4. Set the REFERENCE MODE switch 'up'. In this position the right BNC output is at f, the chop frequency of the outer row of slots; and the left BNC output is at f_{inner}, the chop frequency of the inner row of slots.

5. Connect the lock-in's reference input to the output that corresponds to the row of slots that will be used.

6. Turn the power switch on and adjust the 10-turn dial for the desired chop frequency.

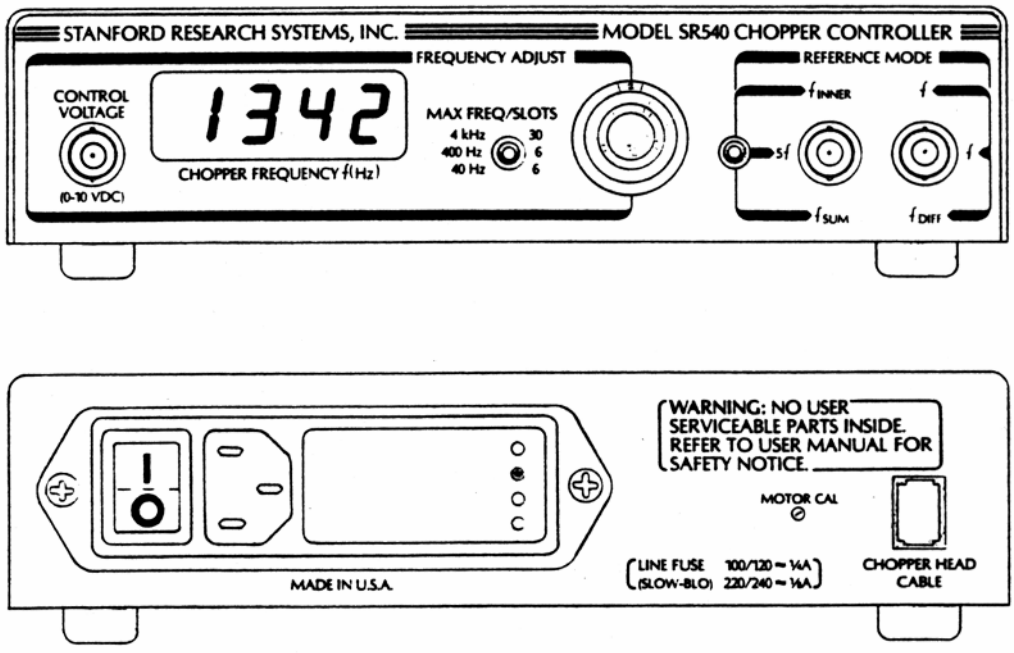


Figure 3 - Chopper Controller Front and Rear Panels

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OPERATING INSTRUCTIONS

INTRODUCTION

The Model SR540 Optical Chopper is used to square-wave modulate the intensity of optical signals. The unit can chop light sources at rates from 4 Hz to 3.7 kHz. Versatile, low jitter reference outputs provide the synchronizing signals required for several operating modes: single or dual beam; sum & difference frequency; and synthesized chopping to 20 kHz.

FREQUENCY OF OPERATION

The choice of operating frequency is influenced by several factors:

1. Avoid low frequency operation (below 100Hz). In general, phase jitter, background noise and lock-in amplifier noise all degrade at low frequencies.

2. Avoid high frequency operation. Motor lifetime will be reduced if the unit is operated for extended periods above 2KHz.

3. Avoid known noise frequencies. For example, the line frequency and all its even and odd harmonics should be carefully avoided.

4. Avoid using the bottom 10% of the frequency control dial. The phase jitter of the reference outputs will degrade at the low end of the range, so switch to the next lower MAX FREQ / SLOTS range.

5. Always use the correct wheel as indicated by the MAX FREQ / SLOTS switch. Using the wrong wheel will seriously degrade the performance of the synthesized reference outputs (left BNC). For frequencies from 4Hz to 400 Hz use the 6/5 slot blade; from 400Hz to 3.7kHz use the 30/25 slot blade.

CHANGING BLADES

The chopper blade (figure 4) may be replaced by removing the three flat head screws, which hold the outside hub to the wheel. When replacing the blade, be sure to insert the blade between the slotted optical detectors before placing it on the wheel. Secure the blade by sandwiching it between the wheel and outer hub. Install and loosely tighten the three flat head screws, which hold the hub to the wheel. Then firmly tighten all three screws. Handle blades carefully as they are easily bent.

BASEPLATE REMOVAL

The baseplate of the unit may be removed to allow for pole mounting. Use an allen wrench to remove the 6-32 bolt from the bottom of the baseplate.

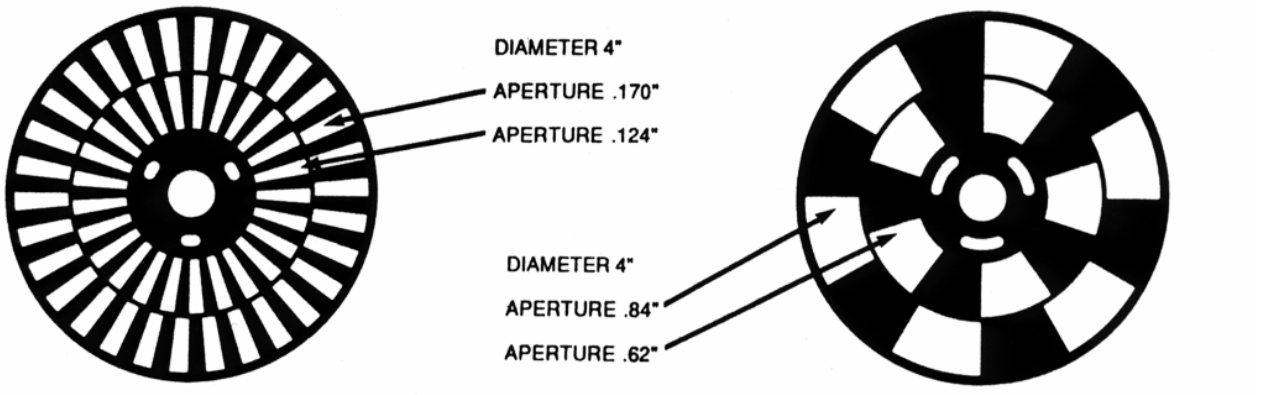


Figure 4 - 30/25 Slot and 6/5 Slot Chopper Blades

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APPLICATIONS

SINGLE BEAM EXPERIMENT

In this application, a single optical beam is chopped by the outer row of slots, and the reference output from the right BNC is used to lock the lock-in amplifier to a chop frequency (figure 5). Note, that the inner row of slots could be used, in which case the reference from the left BNC would be used. In either case, the REFERENCE MODE switch is in the 'up' position.

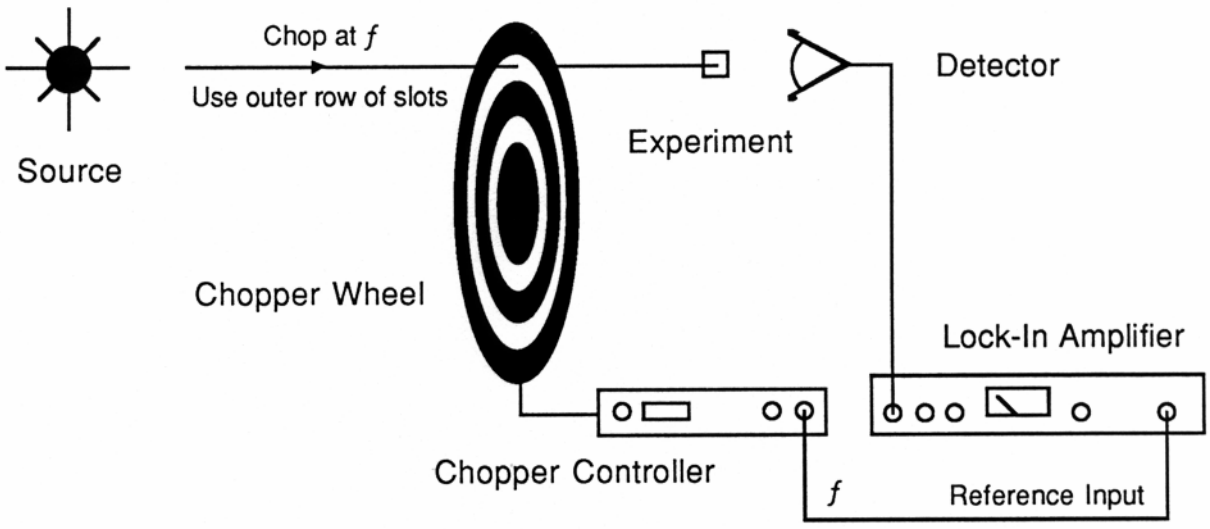


Figure 5 - Single Beam Experiment

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SINGLE BEAM EXPERIMENT WITH EFFECTIVE CHOP FREQUENCIES TO 20 KHZ

In certain situations very high chop frequencies are desirable. For example, you can infer the lifetime of a fluorescent decay by measuring the phase shift between the light which excites the material and the fluorescent decay output.

$$\tau = \tan\phi / 2\pi f$$

where ϕ is the observed phase shift, f is the chop frequency, and t is the lifetime. Accuracy is improved by using a chop frequency,

$$f \sim 1 / 2\pi\tau$$

so that small errors in the phase measurement will not drastically affect the lifetime.

When a small diameter beam is chopped by a blade, the light intensity vs. time is a square wave,

$$I(t) = Io (\sin wt + 1/3 \sin 3wt + 1/5 \sin 5wt + \ldots).$$

Providing that the optical media is not saturated by the light beam, the media will respond linearly to each Fourier component. In this case, we are interested in the response at the 5th harmonic, for which the chopper controller has a reference signal output at $5f$.

To use this feature, set the REFERENCE MODE switch to the center position and use the left BNC reference output as the reference input to the lock-in amplifier (figure 6). The lock-in will now detect the response from the experiment at the 5th harmonic of the chop frequency (up to 20kHz). Note that the

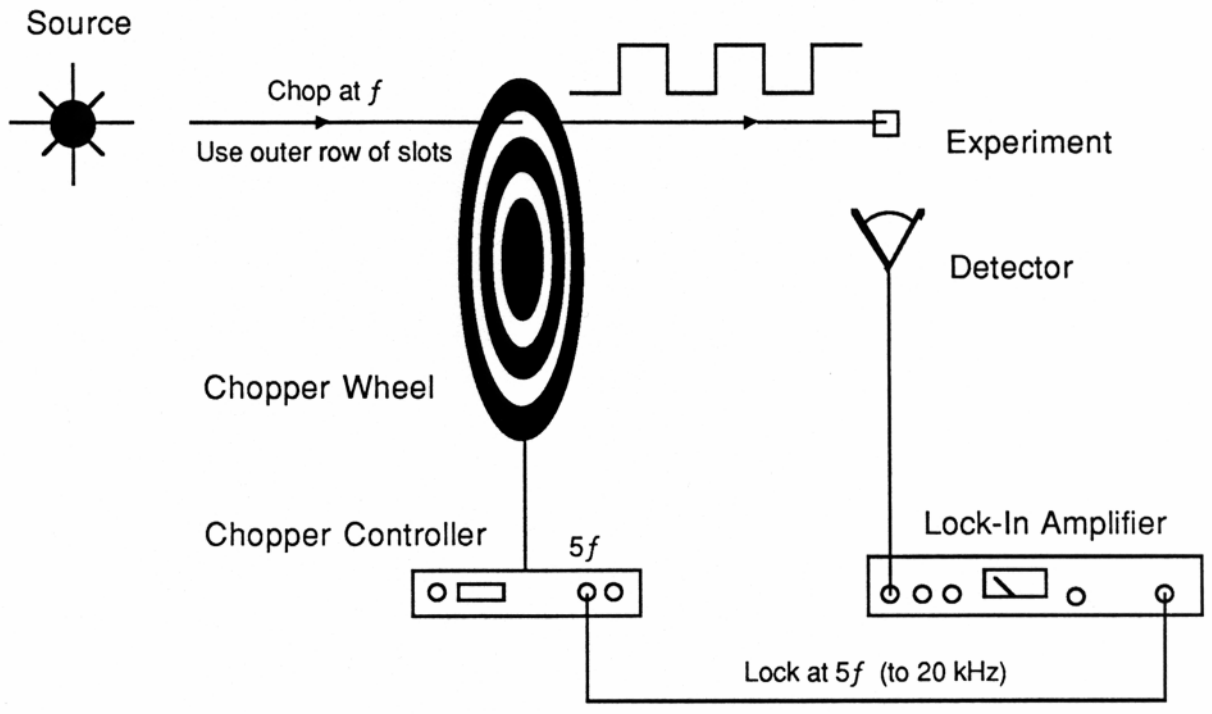


Figure 6 - Single Beam with Effective Chop Frequencies to 20 kHz

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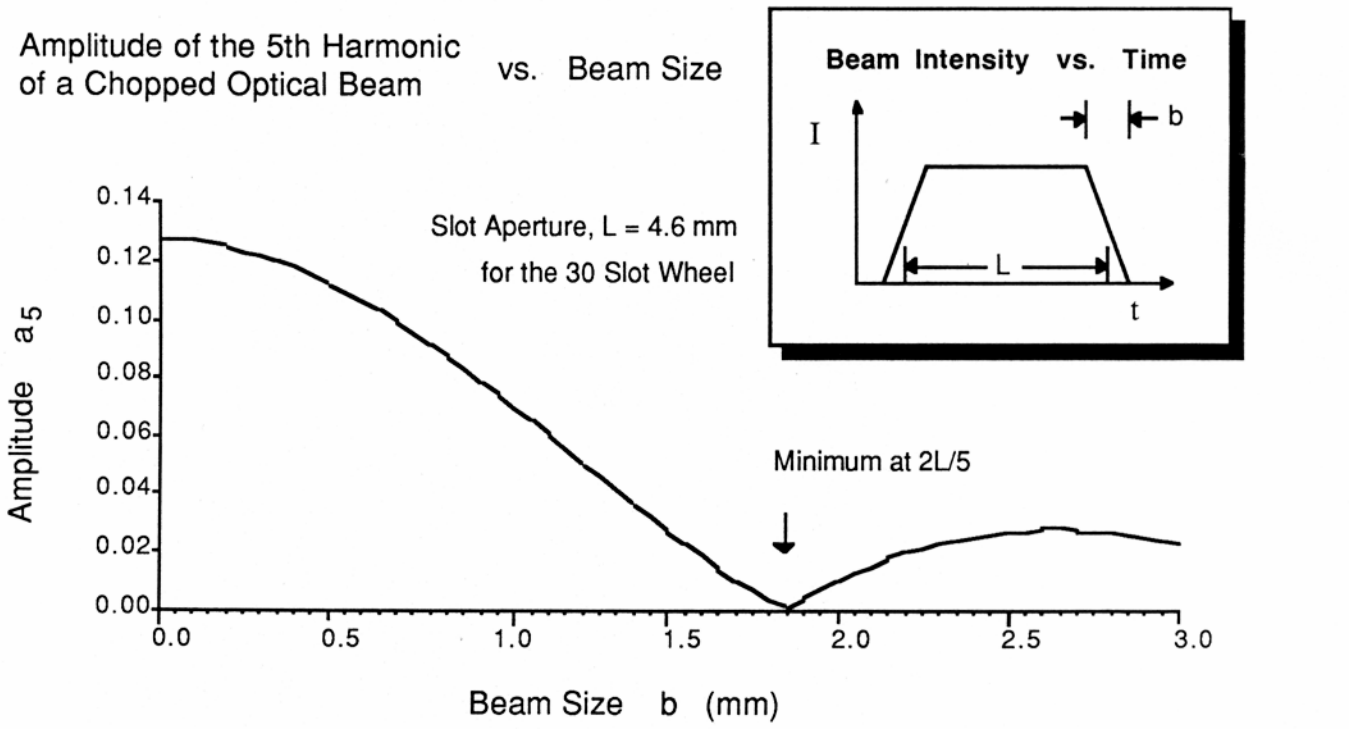


Figure 7 - Amplitude of the 5th Harmonic vs. Beam Size

amplitude of the 5th harmonic term will depend on beam size. For a beam with diameter b, using the 30 slot wheel with a slot aperture L, the amplitude of the nth harmonic is given by,

$$a_n = \frac{4}{n^2\pi^2} \frac{L}{b} \cos\frac{n\pi}{2} (1 - b/L)$$

The amplitude of the 5th harmonic vs. beam size is plotted in figure 7. If your beam is much larger than 0.5mm, you may wish to pass the beam through an aperture or bring it to focus at the chopper blade.

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DUAL BEAM EXPERIMENTS

In this arrangement, the output from a single source is split in two and chopped at two different frequencies by the same chopper wheel (figure 8). One of the beams passes through the experiment, while the other beam, a reference beam, passes through a control arm. The beams are recombined and sent to the same detector.

Two lock-in's are used to detect the two signals which are at different frequencies. The signal at f corresponds to the control arm, the signal at f_{inner} is the response from the experimental arm. If the detected signal in the experimental arm is ratioed to the detected signal in the control arm, then effects due to changing source intensity and detector efficiency are removed.

Also note that each beam passes through one beam splitter, reflects off one beam splitter, and reflects off one mirror, so that effects due to these components are cancelled in the ratio output.

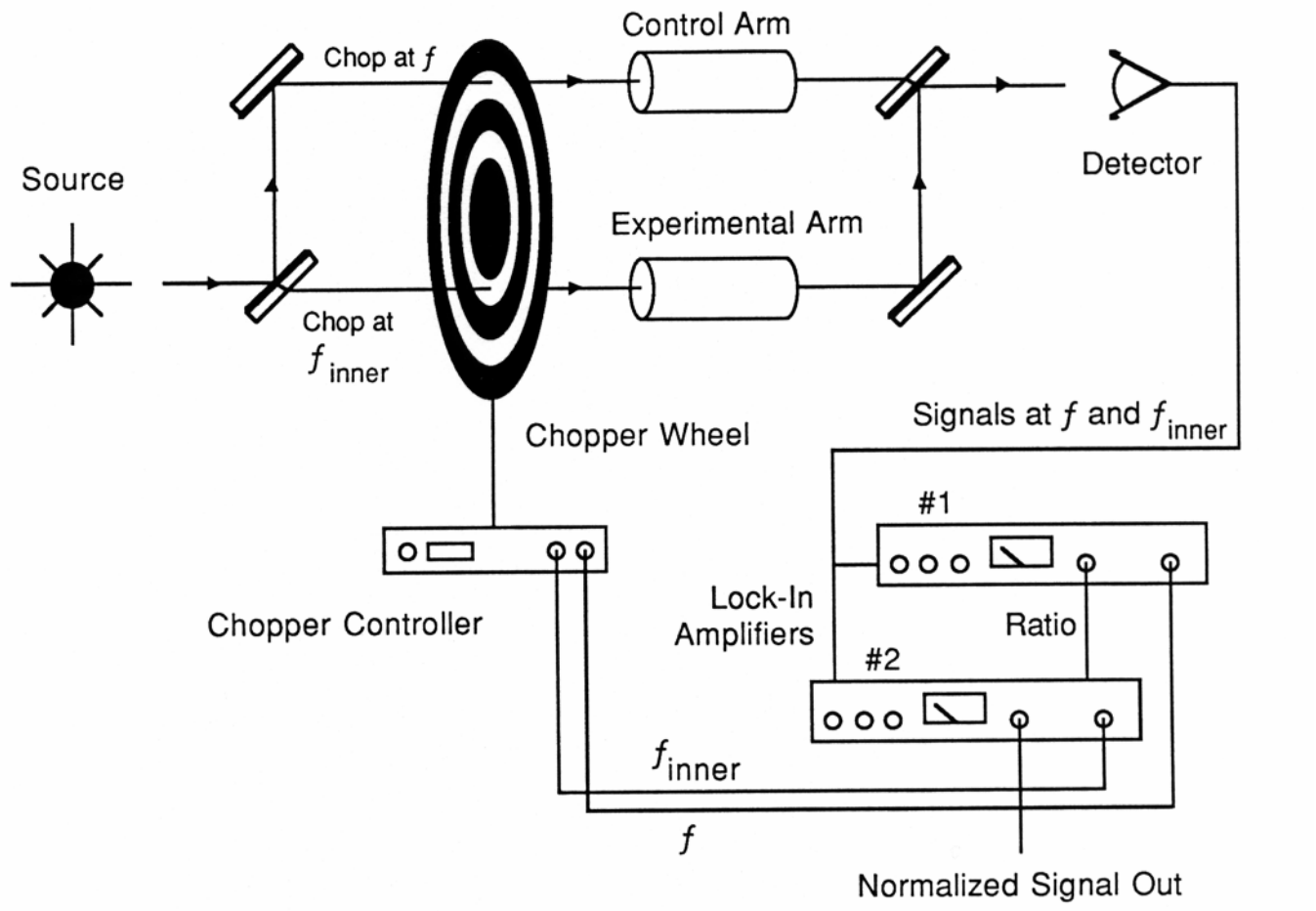


Figure 8 - Dual Beam Experiment

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DETECTION AT THE SUM & DIFFERENCE FREQUENCIES

Certain applications require detection at the sum or difference frequency of two chopped beams. In figure 9, a source beam is split into two. One of the beams is chopped by the outer row of slots on the wheel, the other is chopped by the inner row. By placing the REFERENCE MODE switch in the down position, the sum frequency is available at the left reference BNC and the difference frequency is available at the right BNC.

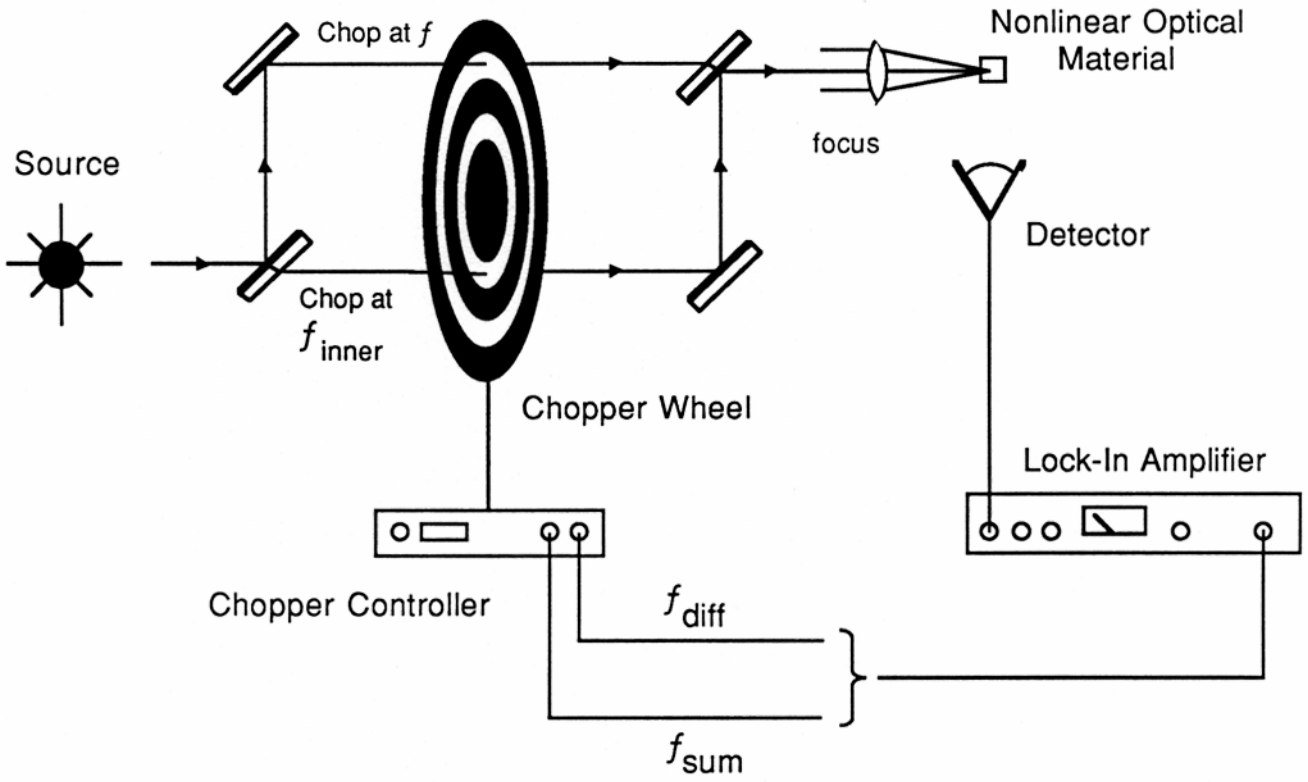


Figure 9 - Sum and Difference Frequency Detection

VARIABLE APERTURE

In some situations one must reduce the duty cycle of a chopped optical beam. This can be done with the SR540 by mounting two identical blades and staggering their position relative to each other.

The minimum slot aperture is about 0.5mm, below which the slotted optical detector will fail to detect the outer row of slots. This corresponds to a 10%duty cycle on the 30 slot blade and a 2% duty cycle on the 6 slot blade. For duty cycles less than 20%, you should select the "pulse mode" reference level on the lock-in. Since the $f/6$ notch is obscured when two blades are mounted, only the f & $5f$ reference outputs will work (f_{inner}, f_{sum}, and f_{diff} will not work). You may observe the duty cycle of the chopped beam on the f output.

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CALIBRATION

Only one adjustment is required to calibrate the SR540 Chopper Controller. The adjustment pot located on the rear panel is used to match the controller to the motor. Mount the 30-slot blade, and set the MAX FREQ/SLOT switch to 4 kHz. Set the FREQUENCY ADJUST dial to 7.5, and use a small screwdriver to adjust the MOTOR CAL pot so that the four digit display shows 3000 ±10 Hz.

CIRCUIT DESCRIPTION

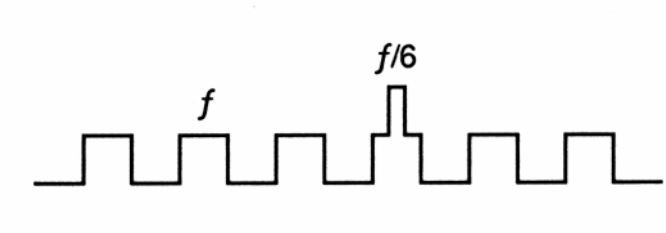
MOTOR SPEED CONTROL

The output of U5, a precision 10.000VDC reference, is attenuated by P2, the ten-turn potentiometer, to control the motor speed. The set voltage can be overridden by a voltage at the CONTROL VOLTAGE input. The speed control voltage is buffered by 2/4 of U3, and attenuated by R8, R9 and R10. U2, a quad analog switch, selects the attenuation factor to provide full-scale voltages of 10.0, 5.0 or 0.5VDC per the setting of the MAX FREQ/SLOTS switch. The 3/4 of U3 is used to amplify this voltage by about x2.6. The MOTOR CAL pot, P1, is used to adjust the gain of this amplifier to compensate for variations between motors. The output of the amplifier is buffered by U1 to drive the motor. R4 senses and limits the motor current to 200mA by turning on Q1. The 1/4 of U3 feeds-back a voltage equal to the voltage applied to the motor minus 4.7 times the voltage across R4. Since the feedback voltage goes down when current is increased, the voltage applied to the motor will go up; hence the output behaves like a negative resistance connected to a voltage source. The negative resistance is about R4 x 4.7, ~ 15Ω. This is just equal to the real resistance of the cable and motor windings. With this arrangement, the speed of the motor will not be affected by load variations, which normally would change the current and so change the voltage that is applied to the motor. This improves frequency stability of the chopper and improves the linearity of the speed vs. control voltage characteristic.

OPTICAL PICK-OFFS

There are two slotted optical switches, which detect slots in the chopper wheel. Each optical switch uses an infrared LED and a phototransistor. If the light passes through a slot to the phototransistor, its collector current will be several milliamps. The collectors of the photo transistors are connected together, summing their currents. The common collector is held at 3.0VDC by 4/4 of U3. The current is sensed by R15, so that the output of 4/4 U3 will swing by 1 volt/mA of collector current. Radiated noise at the chop frequency is greatly reduced, as all lines going to the chopper head are held at constant voltage.

The waveform at pin 14 of U3 looks like this:



The current from one of the optical switches is just a square wave at the frequency of the outer row of slots. The outputs from the second photo

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transistor places a pulse on top of every sixth pulse, per the chopper wheel design. This second signal provides a signal at f/6, with known phase, which is used to synthesize other reference outputs.

Logic signals at f & f/6 are generated by the dual comparator U6. The 1/2 of U6 compares the photo current signal to a fixed voltage of about 3.6VDC in order to generate f. The 2/2 of U6 compares the photo current signal to the peak value of the photo current signal, less two diode drops. Comparing to the peak voltage compensates for variations in LED & phototransistor sensitivity. Both comparators have about 0.2V of hysteresis to prevent multiple edges on logic transitions.

FREQUENCY SYNTHESIS

The outer row frequency, f, is measured directly by one of the phototransistors. The difference between the outer & inner row frequencies, f/6, is measured by the other phototransistor. The other frequencies are synthesized from these two references by a phase-lock loop circuit.

Name	Frequency	Description
f	f	outer row
$5f$	$5f$	5 x outer row
f_{inner}	$5f/6$	inner row
f_{sum}	$11f/6$	outer row + inner row
f_{diff}	$f/6$	outer row – inner row

The Dual 1:4 Multiplexer, U17, is used to pass f or f/6 to the right hand reference output BNC per the setting of the REFERENCE MODE switch, SW1. U17 also selects f of f/6 as a source to the PLL frequency synthesizer circuit.

To generate 5f/6, the frequency of the inner row of slots, U17 selects f/6 as the input to the phase detector of U12, a CMOS phase-lock loop. The output of the phase detector is filtered by R23, R24, and C3. The quad analog switch, U4, will also switch in C2 or C1 if the 400Hz or 40Hz MAX FREQ/SLOTS ranges are selected at SW2. The filtered output of the phase detector controls the VCO frequency. The maximum frequency of the VCO is set by R22. U4 increases the maximum frequency by switching in R20 or R21 when the 400 Hz or 4KHz ranges are selected. The output frequency of the VCO is divided by U18, which is programmed to divide by 5 or 11 per the setting of the REFERENCE MODE switch, SW1. To generate 5f/6, U18 loads 10 when the counter reaches 15 to divide by 5. In order for the frequencies at the input of the phase comparator to be equal, the VCO must run at 5xf/6.

The same circuit is used to generate 5f, however, the multiplexer, U17, selects f (not f/6) as the input to the phase detector. To generate 11f/6, the sum frequency, f/6 is selected as the input to the phase detector, and U18 is programmed to divide by 11 by presetting to 4 when the counter reaches 15. In all cases, the output of the VCO is passed to the left reference output BNC. This output is always a square wave.

FREQUENCY DISPLAY

The four-digit frequency display always shows the frequency, f, of the outer row of slots, independent of the reference mode, which has been selected. The time base for the counter is a 32,768Hz crystal oscillator, which is sustained by U10, a hex inverter. U11, a 14-stage binary counter and the flip-flop 2/2 U14 are used to divide by 215 to generate a 1.000-second gate.

In order to eliminate one-count flicker in the result, the count latch 1/2 U14, is set by a falling edge of the wave form which is to be counted. When the count latch is set, the reset to the time base counters is released, starting the one-second-count period. Also, the reset to U15, the four-decade counter/latch/display driver is released to begin the count. The count accumulates for 1 second, when, the falling edge of the Q output from 2/2 U14 sets 1/2 U13 high. The Q output of 1/2 U13 stays high for about 1/2 clock period (15µs) asserting the Latch Enable input on U15 to transfer the counter contents to the latch for display. Then 1/2 U13 is reset, and 2/2 U13 is clocked high, asserting

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the Q-bar output to reset the count latch. The entire count cycle begins with the next falling edge from the opto pick-off comparator. If the wheel stops, so there are no more pulses to count, the reset to U15 will be asserted indefinitely. After a few seconds, R36 will charge C13 to assert the Disp Sel to U15, causing the contents of the counters (which are zero) to be displayed instead of the contents of the latches (which contain the last count). U15 multiplexes the display information to the 4 digit common cathode LED. Each of the digits are selected in sequence by U15 saturating one of the display driver transistors Q2-Q5.

POWER SUPPLIES

The power transformer primary is tapped for operation at 100, 120, 220, or 240VAC. The power entry module does the required switching. Full wave bridge rectifiers are used to rectify the 7.5VAC and 30VAC to 8.5VDC and 40VDC. The unregulated 40VDC is used by U1 the motor driver transistor, and by U8 to provide regulated 30VDC. The 30VDC is the DC supply to U7, a +15VDC regulator. U9 regulates the 8.5VDC to 5.0VDC.

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SR540 PARTS LIST

Motor and Motor related Parts List

C 15	5-00102-517	4.7U	Capacitor, Tantalum, 35V, 20%, Rad
J 2	1-00030-100	4P4C	Connector, Misc.
M 1	7-00055-700	12VDC	Misc. Parts
O 1	3-00173-309	MOC70U2	Optical Switch
O 2	3-00173-309	MOC70U2	Optical Switch
PC1	7-00056-701	SR541	Printed Circuit Board
R 30	0-00000-000	UNDECIDED PART	Hardware, Misc.
R 33	0-00000-000	UNDECIDED PART	Hardware, Misc.
Z 0	0-00146-025	6-32X3/8H	Screw, Allen Head, HEX HEAD
Z 0	0-00147-004	1/4-20X1"	Knobs
Z 0	0-00150-026	4-40X1/4PF	Screw, Black, All Types
Z 0	0-00151-055	DC-44-4C-6	Wire, Other
Z 0	0-00205-058	EPOXY GLUE	Glue
Z 0	0-00222-021	6-32X1/4PP	Screw, Panhead Phillips
Z 0	7-00057-720	SR540-1	Fabricated Part
Z 0	7-00058-716	SR540-10	Chemically Etched Part
Z 0	7-00059-721	SR540-2	Machined Part
Z 0	7-00060-721	SR540-3	Machined Part
Z 0	7-00061-721	SR540-6	Machined Part
Z 0	7-00062-716	SR540-9	Chemically Etched Part

Main Board and Chassis Assembly Parts List

BR1	3-00062-340	KBP201G/BR-81D	Integrated Circuit (Thru-hole Pkg)
BR2	3-00062-340	KBP201G/BR-81D	Integrated Circuit (Thru-hole Pkg)
C 1	5-00031-520	220U	Capacitor, Electrolytic, 16V, 20%, Rad
C 2	5-00033-520	47U	Capacitor, Electrolytic, 16V, 20%, Rad
C 3	5-00192-542	22U MIN	Cap, Mini Electrolytic, 50V, 20% Radial
C 4	5-00100-517	2.2U	Capacitor, Tantalum, 35V, 20%, Rad
C 5	5-00127-524	2.2U	Capacitor, Tantalum, 50V, 20%, Rad
C 6	5-00128-509	470U	Capacitor, Electrolytic, 50V, 20%, Rad
C 7	5-00023-529	.1U	Cap, Monolythic Ceramic, 50V, 20%, Z5U
C 8	5-00038-509	10U	Capacitor, Electrolytic, 50V, 20%, Rad
C 9	0-00772-000	1.5" WIRE	Hardware, Misc.
C 10	5-00064-513	.0047U	Capacitor, Mylar/Poly, 50V, 5%, Rad
C 11	5-00100-517	2.2U	Capacitor, Tantalum, 35V, 20%, Rad
C 12	5-00030-520	2200U	Capacitor, Electrolytic, 16V, 20%, Rad
C 13	5-00038-509	10U	Capacitor, Electrolytic, 50V, 20%, Rad
C 14	5-00100-517	2.2U	Capacitor, Tantalum, 35V, 20%, Rad
C 17	5-00023-529	.1U	Cap, Monolythic Ceramic, 50V, 20%, Z5U
C 18	5-00100-517	2.2U	Capacitor, Tantalum, 35V, 20%, Rad
C 19	5-00192-542	22U MIN	Cap, Mini Electrolytic, 50V, 20% Radial
C 20	5-00064-513	.0047U	Capacitor, Mylar/Poly, 50V, 5%, Rad
CX1	5-00003-501	10P	Capacitor, Ceramic Disc, 50V, 10%, SL
CX2	5-00017-501	47P	Capacitor, Ceramic Disc, 50V, 10%, SL
D 1	3-00004-301	1N4148	Diode
D 2	3-00004-301	1N4148	Diode

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SR540 PARTS LIST

D 3	3-00001-301	1N4001	Diode
D 4	3-00001-301	1N4001	Diode
DX100	3-00203-301	1N5711	Diode
F 1	6-00002-611	.25A 3AG	Fuse
J 1	1-00030-100	4P4C	Connector, Misc.
J 3	1-00031-133	16 PIN SRA	Connector, Male, Right Angle
P 1	4-00271-445	2.0K	Pot, Multi-Turn, Side Adjust
P 2	4-00019-443	20K	Pot, 10-Turn Panel
PC1	7-00054-701	SR540	Printed Circuit Board
PC2	7-00558-701	SR540 LED	Printed Circuit Board
Q 2	3-01860-325	MPSA13	Transistor, TO-92 Package
Q 3	3-01860-325	MPSA13	Transistor, TO-92 Package
Q 4	3-01860-325	MPSA13	Transistor, TO-92 Package
Q 5	3-01860-325	MPSA13	Transistor, TO-92 Package
Q 6	3-00020-325	PN2222	Transistor, TO-92 Package
R 2	4-00273-401	5.6K	Resistor, Carbon Film, 1/4W, 5%
R 3	4-00305-401	4.3K	Resistor, Carbon Film, 1/4W, 5%
R 4	4-00773-402	2.2	Resistor, Carbon Comp, 1/2W, 5%
R 5	4-00031-401	100	Resistor, Carbon Film, 1/4W, 5%
R 6	4-00034-401	10K	Resistor, Carbon Film, 1/4W, 5%
R 7	4-00034-401	10K	Resistor, Carbon Film, 1/4W, 5%
R 8	4-00188-407	4.99K	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 9	4-00187-407	4.53K	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 10	4-00193-407	499	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 11	4-00061-401	240K	Resistor, Carbon Film, 1/4W, 5%
R 12	4-00034-401	10K	Resistor, Carbon Film, 1/4W, 5%
R 13	4-00048-401	2.2K	Resistor, Carbon Film, 1/4W, 5%
R 14	4-00078-401	39K	Resistor, Carbon Film, 1/4W, 5%
R 15	4-00021-401	1.0K	Resistor, Carbon Film, 1/4W, 5%
R 16	4-00272-407	221	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 17	4-00188-407	4.99K	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 18	4-00021-401	1.0K	Resistor, Carbon Film, 1/4W, 5%
R 19	4-00059-401	22K	Resistor, Carbon Film, 1/4W, 5%
R 20	4-00614-407	174K	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 21	4-00037-401	11K	Resistor, Carbon Film, 1/4W, 5%
R 22	4-00131-407	1.00M	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 23	4-00094-401	6.8K	Resistor, Carbon Film, 1/4W, 5%
R 24	4-00090-401	560	Resistor, Carbon Film, 1/4W, 5%
R 25	4-00054-401	200K	Resistor, Carbon Film, 1/4W, 5%
R 26	4-00035-401	10M	Resistor, Carbon Film, 1/4W, 5%
R 28	4-00021-401	1.0K	Resistor, Carbon Film, 1/4W, 5%
R 29	4-00034-401	10K	Resistor, Carbon Film, 1/4W, 5%
R 31	4-00032-401	100K	Resistor, Carbon Film, 1/4W, 5%
R 32	4-00032-401	100K	Resistor, Carbon Film, 1/4W, 5%
R 34	4-00057-401	220	Resistor, Carbon Film, 1/4W, 5%
R 35	4-00057-401	220	Resistor, Carbon Film, 1/4W, 5%
R 36	4-00032-401	100K	Resistor, Carbon Film, 1/4W, 5%
R 37	4-00034-401	10K	Resistor, Carbon Film, 1/4W, 5%

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SR540 PARTS LIST

R 38	4-00034-401	10K	Resistor, Carbon Film, 1/4W, 5%
R 39	4-00273-401	5.6K	Resistor, Carbon Film, 1/4W, 5%
R 40	4-00024-401	1.2K	Resistor, Carbon Film, 1/4W, 5%
R 41	4-00031-401	100	Resistor, Carbon Film, 1/4W, 5%
R 42	4-00021-401	1.0K	Resistor, Carbon Film, 1/4W, 5%
R 43	4-00059-401	22K	Resistor, Carbon Film, 1/4W, 5%
R 44	4-00021-401	1.0K	Resistor, Carbon Film, 1/4W, 5%
R 45	4-00022-401	1.0M	Resistor, Carbon Film, 1/4W, 5%
R 99	4-00081-401	470	Resistor, Carbon Film, 1/4W, 5%
R 100	4-00355-435	56V/500A	Varistor, Zinc Oxide Nonlinear Resistor
SW1	2-00012-206	SPDT	Switch, On-Off-On, Toggle,Right Angle
SW2	2-00012-206	SPDT	Switch, On-Off-On, Toggle,Right Angle
T 1	6-00014-610	SR540	Transformer
TH100	4-00766-431	RXE030	Thermistor, various
U 1	3-00257-329	TIP41B	Voltage Reg., TO-220 (TAB) Package
U 2	3-00074-340	CD4066	Integrated Circuit (Thru-hole Pkg)
U 3	3-00098-340	LM324	Integrated Circuit (Thru-hole Pkg)
U 4	3-00074-340	CD4066	Integrated Circuit (Thru-hole Pkg)
U 5	3-00188-340	LH0070-0H	Integrated Circuit (Thru-hole Pkg)
U 6	3-00143-340	LM393	Integrated Circuit (Thru-hole Pkg)
U 7	3-00114-329	7815	Voltage Reg., TO-220 (TAB) Package
U 8	3-00149-329	LM317T	Voltage Reg., TO-220 (TAB) Package
U 9	3-00112-329	7805	Voltage Reg., TO-220 (TAB) Package
U 10	3-00051-340	74HCU04	Integrated Circuit (Thru-hole Pkg)
U 11	3-00169-340	74HC4020	Integrated Circuit (Thru-hole Pkg)
U 12	3-00072-340	CD4046	Integrated Circuit (Thru-hole Pkg)
U 13	3-00048-340	74HC73	Integrated Circuit (Thru-hole Pkg)
U 14	3-00048-340	74HC73	Integrated Circuit (Thru-hole Pkg)
U 15	3-00170-340	74C926	Integrated Circuit (Thru-hole Pkg)
U 17	3-00166-340	74HC153	Integrated Circuit (Thru-hole Pkg)
U 18	3-00171-340	74HC191	Integrated Circuit (Thru-hole Pkg)
XT1	6-00015-620	32.768 KHZ	Crystal
Z 0	0-00002-008	2607	Dial
Z 0	0-00009-000	FOOT	Hardware, Misc.
Z 0	0-00025-005	3/8"	Lugs
Z 0	0-00048-011	6-32 KEP	Nut, Kep
Z 0	0-00089-033	4"	Tie
Z 0	0-00103-040	3/8X3/32	Washer, Flat
Z 0	0-00127-050	4" #18 RED	Wire #18 UL1007 Stripped 3/8x3/8 No Tin
Z 0	0-00128-053	4" #24	Wire #24 UL1007 Strip 1/4x1/4 Tin
Z 0	0-00129-053	5" #24	Wire #24 UL1007 Strip 1/4x1/4 Tin
Z 0	0-00134-053	7-1/4" #24	Wire #24 UL1007 Strip 1/4x1/4 Tin
Z 0	0-00149-020	4-40X1/4PF	Screw, Flathead Phillips
Z 0	0-00153-057	GROMMET2	Grommet
Z 0	0-00155-002	6VM4S	Power Entry Hardware
Z 0	0-00185-021	6-32X3/8PP	Screw, Panhead Phillips
Z 0	0-00207-003	TO-5	Insulators
Z 0	0-00209-021	4-40X3/8PP	Screw, Panhead Phillips

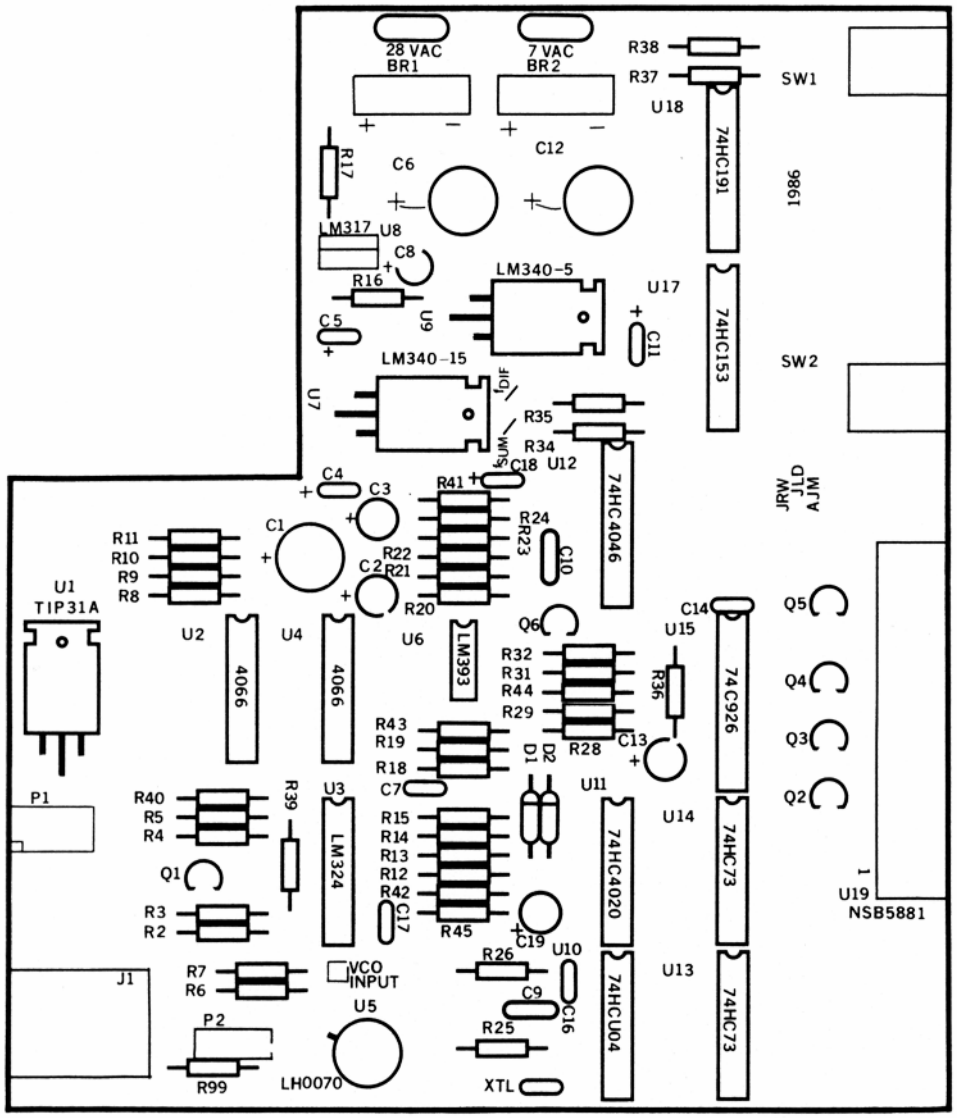
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SR540 PARTS LIST

Z 0	0-00222-021	6-32X1/4PP	Screw, Panhead Phillips
Z 0	0-00238-026	6-32X1/4PF	Screw, Black, All Types
Z 0	0-00447-007	TO-220	Heat Sinks
Z 0	0-00524-048	8-1/4" #18	Wire, #18 UL1015 Strip 3/8 x 3/8 No Tin
Z 0	0-00594-050	4-1/2" #18 BLUE	Wire #18 UL1007 Stripped 3/8x3/8 No Tin
Z 0	1-00003-120	BNC	Connector, BNC
Z 0	1-00053-172	USA	Line Cord
Z 0	3-00556-340	HDSP-5323	Integrated Circuit (Thru-hole Pkg)
Z 0	7-00064-720	SR540-7	Fabricated Part
Z 0	7-00065-720	SR540-8	Fabricated Part
Z 0	7-00066-709	SR540-11	Lexan Overlay

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PC LAYOUT



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