

An Analog Synthesizer for the 21st Century

**A collection of schematics to build a complete,
Two oscillator analog synthesizer**

By Thomas Henry

An Analog Synthesizer for the 21st Century
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First Edition

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Introduction

Okay, three years is far too long to keep a secret.

This is a 36 page collection of schematics and parts lists for a very complete, accurate and versatile analog synth. I set myself a goal of making these top-of-the-line circuits, and in fact claim (rather immodestly) that these are the best I've ever come up with. Actually, one other person has seen and beta-tested them, our own Scott Stites of the non-evolutionary famed state of Kansas. I'm hoping he'll back up my claim that the title is well-deserved.

And by the way, there are no hard-to-find parts in the circuits.

To whet your appetite, the modules described in the schematics are:

Power Supply
Two VCOs
State Variable VCF
VCA
ADSR
VC Noise Source
VC Phase Shifter
LFO Deluxe
Sample and Hold
Complete Patchover Scheme

I might mention that the LFO does everything but clean the toilets; you simply won't believe the versatility of this thing. Scott claims to have been biting his tongue on this, and just to put him out of his misery, I decided to release it, too. (I saw National Lampoon's Vacation and know how much those Kansans treasure their tongues; move over Cousin Eddie).

And of course, you'll find all of the usual niceties: goof-proof inputs and outputs, standard voltage and impedance levels, exponential response on the Noise and Phase Shifter, etc.

Finally, I should mention that this is a set of plans (schematics and parts lists only), not a book of step-by-step instructions. It really isn't for beginners, but rather for someone who has gotten their DIY chops down and is anxious to see the real work.

Like I said, three years is too long to keep a secret. The time is right to get this out. I'll be curious to learn what you all think of it.

Thomas Henry

About the Author

Thomas Henry is the author of over 100 articles and two books on the subjects of electronic music, microcomputers, astronomy, and caves. While in school he helped form the East Side Pharaohs (the Midwest's zaniest band) in which he played guitar and sang bass for nearly 18 years. After attaining in M.A. in mathematics, he taught at the collegiate level for ten years. His leisure time activities include bird watching, caving, amateur astronomy, magic, road trips to national parks, and flower gardening. The bat is his favorite mammal.

Editors Note: In the winter of 2005, I was approached by Scott Stites. Scott is an avid electronics hobbyist who had been working with Thomas Henry testing and prototyping several circuits, some of which were slated to appear in a new book. Unfortunately, Thomas had recently decided to pull the plug on his business, "Midwest Analog." The decision was a good one for Mr. Henry, and it allowed him to pursue one of his other loves, teaching, full-time. Unfortunately, this left no distribution outlet for the Thomas Henry "Cookbook" series. These books had reached near-legendary status among synthesizer hobbyists, and many people wondered if they were going to join the ranks of the myriad other out-of-print books treasured by synth fans. Scott had followed my posts on the Synthesizer DIY mailing list during a particularly interesting discussion about copyright laws and whether copying was okay in cases where publications (like the Thomas Henry books) were no longer available. Despite all logic, Scott thought I might be a good choice to carry on distributing the books. I contacted John Mahoney, with whom I had worked before, and asked if he wanted to join in on a possible venture to publish Thomas' work. The reply was an immediate and enthusiastic "yes!" And so, Magic Smoke Electronics was born. Although we have plans to create additional books and circuit kits, if we do nothing other than provide an outlet for Thomas' existing body of work, we'll consider Magic Smoke a success. John and I would like to thank Mr. Henry for allowing us to continue publishing these books, and we hope you, the reader, will enjoy them as much as we have.

Tim (Servo) Parkhurst
John Mahoney

An Analog Synthesizer for the 21st Century

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1.0 POWER SUPPLY PARTS LIST

RESISTORS (fixed resistors are 1/4 Watt, 5% values)

R1 1.5K

CAPACITORS

C1 - C3 10µF, 25V electrolytic
C4, C5 1000µF, 50V electrolytic
C6 2200µF, 25V electrolytic

SEMICONDUCTORS

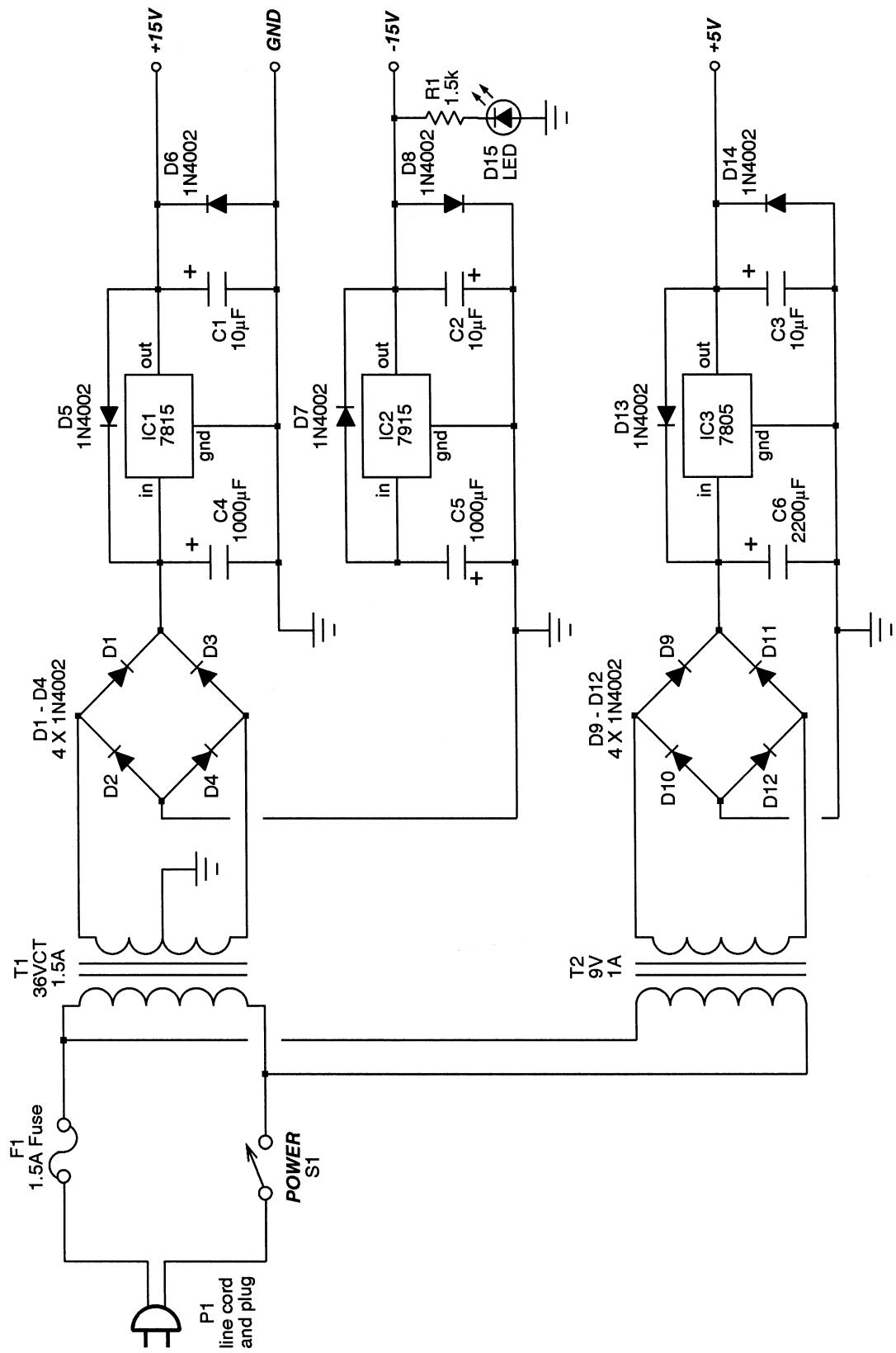
D1 - D14 1N4002 rectifier
D15 LED, red
IC1 7815 voltage regulator
IC2 7915 voltage regulator
IC3 7805 voltage regulator

OTHER

T1 36VCT, 1.5A transformer
T2 9V, 1A transformer
S1 SPST heavy-duty toggle switch
F1 1.5A fast-blow fuse
P1 18 gauge line cord with plug

MISCELLANEOUS

Printed circuit board, heat sinks, panel mount fuse holder, heat shrink tubing, LED clip, #4 hardware (nuts, bolts, lock washers), wire, heat sink grease, solder, etc.



2.0 ADSR PARTS LIST

RESISTORS (fixed resistors are 1/4 Watt, 5% values)

R1, R2	2K
R3	5.1K
R4 - R7	10K
R8	10K linear potentiometer
R9	47K
R10 - R12	100K
R13	1M
R14 - R16	1M linear potentiometer

CAPACITORS (all are 16V or better)

C1	470pF disk
C2 - C5	0.01μF disk
C6, C7	4.7μF electrolytic
C8, C9	10μF electrolytic

SEMICONDUCTORS

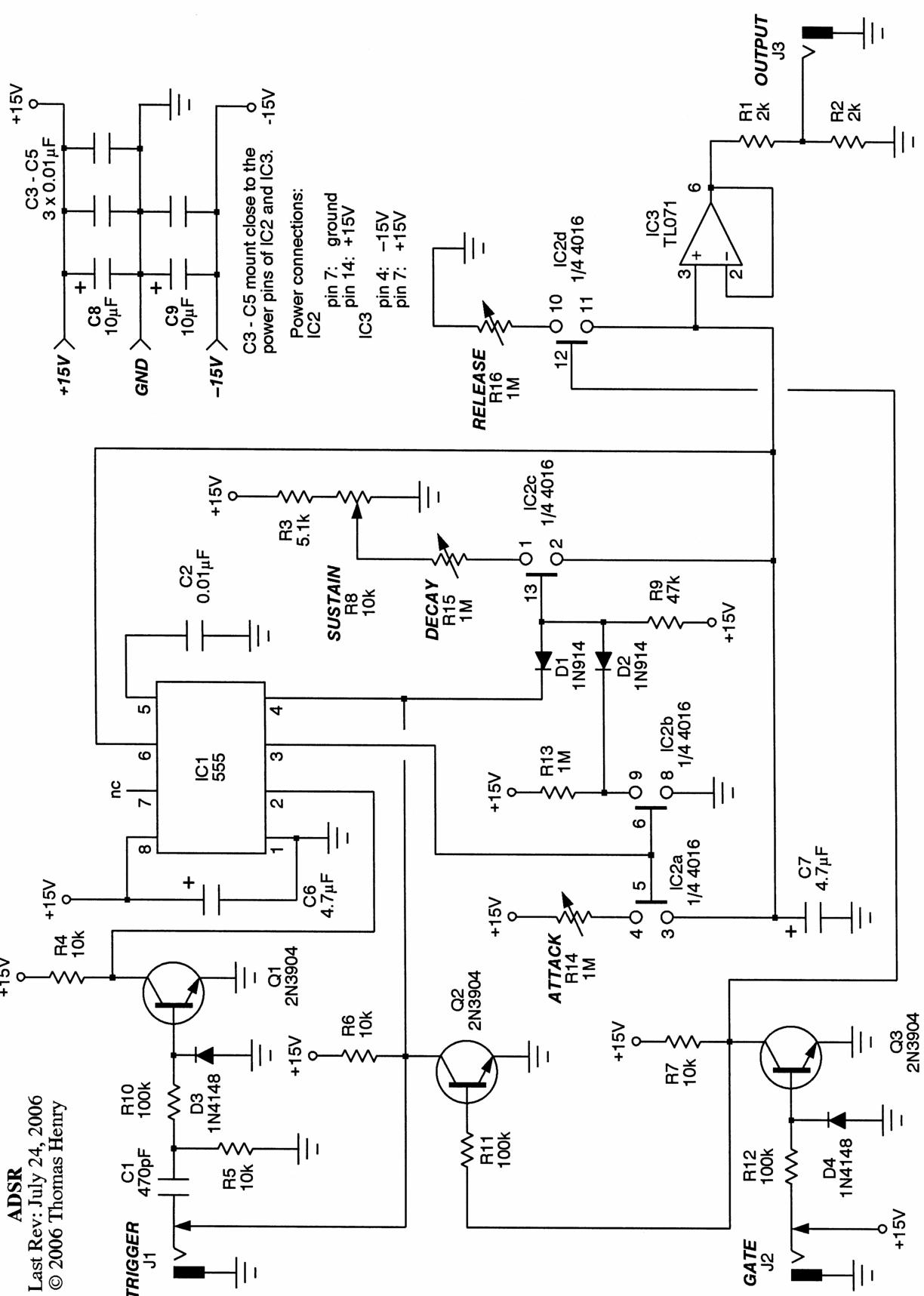
D1 - D4	1N4148
Q1 - Q3	2N3904
IC1	555 timer
IC2	4106 quad CMOS switch
IC3	TL071 op amp

OTHER

J1, J2	1/4" phone jack, n.c.
J3	1/4" phone jack, n.o.

MISCELLANEOUS

Printed circuit board, IC sockets, front panel, knobs, wire, solder, etc.



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3.0 XR VCO PARTS LIST

RESISTORS (fixed resistors are 1/4 Watt, 5% values)

R1	100 Ohm trimmer
R2	390 Ohm
R3	500 Ohm trimmer
R4, R5	1K
R6	1.8K
R7	2K, +3500ppm/°C thermistor
R8	2.2K
R9	3K
R10 - R12	4.7K
R13, R14	5.6K
R15 - R19	10K
R20	11K
R21	20K (Note: Increase R21 to 22K or even 24K if sine amplitude is shy of ±5V)
R22	25K trimmer
R23	47K
R24	50K trimmer
R25	82K
R26 – R31	100K
R32 – R37	100K linear potentiometer
R38	150K
R39	200K
R40, R41	220K
R42	1M trimmer
R43	1.5M
R44, R45	2.2M
R46	3.3M

CAPACITORS (all are 16V or better)

C1	100pF disk
C2	470pF disk
C3 – C6	0.01µF disk
C7	0.047µF mylar
C8	0.22µF mylar
C9, C10	4.7µF electrolytic
C11 – C13	10µF electrolytic

SEMICONDUCTORS

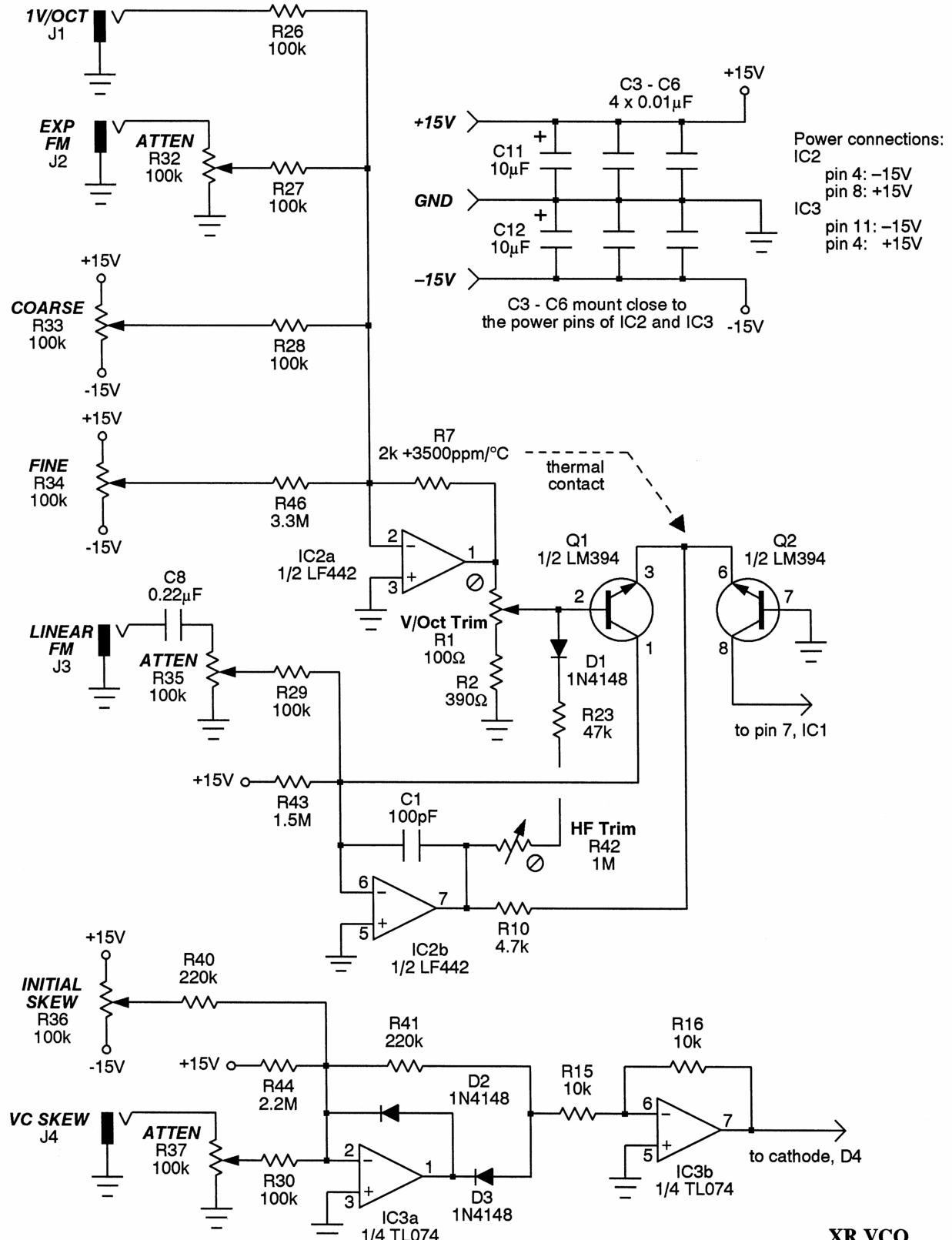
D1 – D6	1N4148 diode
Q1, Q2	LM394 matched transistor pair
Q3	2N3904
IC1	XR-2206 function generator
IC2	LF442 dual op-amp
IC3	TL074 quad op-amp

OTHER

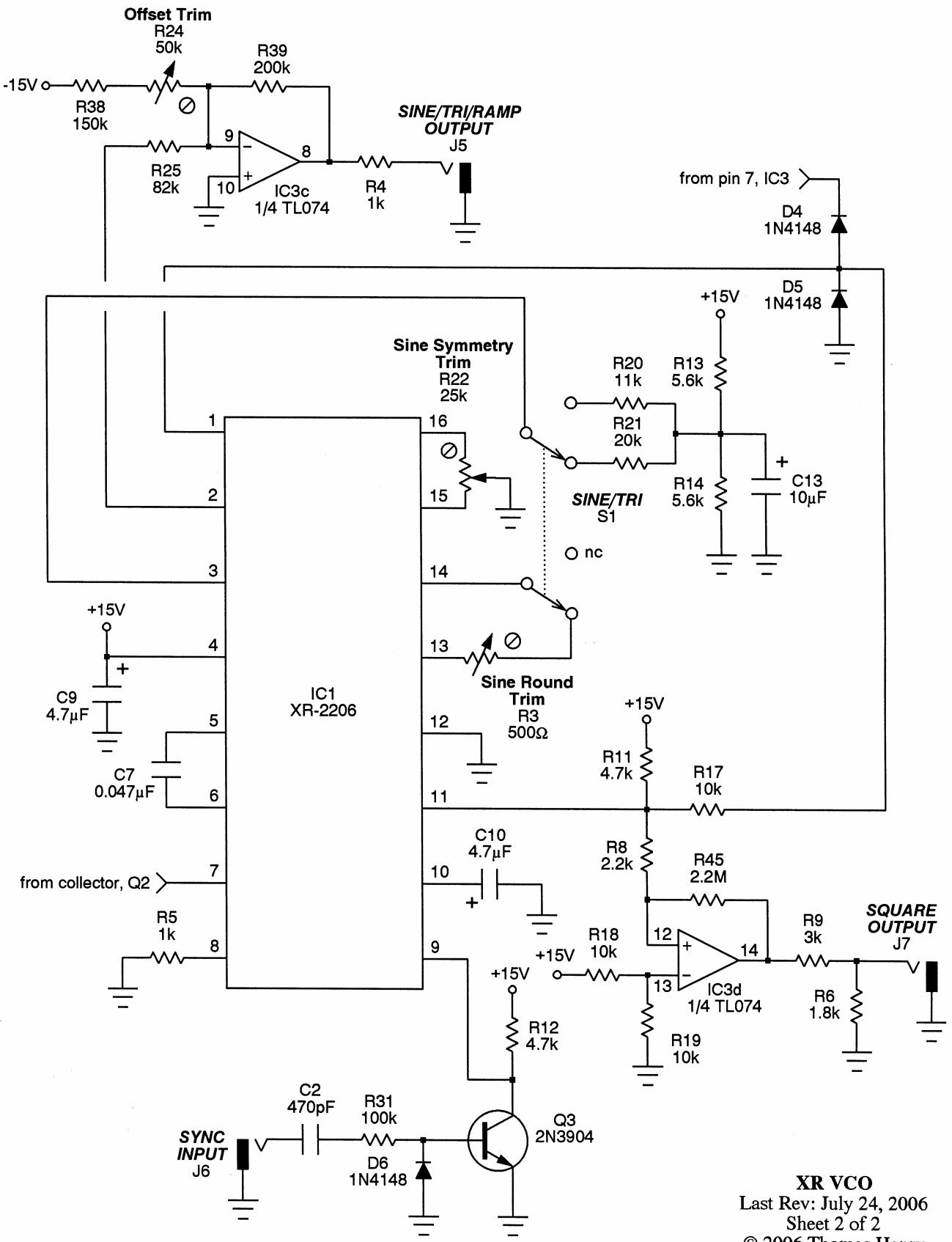
J1 – J7	1/4" phone jack, n.o.
S1	DPDT toggle switch

MISCELLANEOUS

Printed circuit board, IC sockets, front panel, knobs, wire, solder, heat sink grease, etc.



XR VCO
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 Sheet 1 of 2
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XR VCO
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4.0 LM VCO PARTS LIST

RESISTORS (fixed resistors are 1/4 Watt, 5% values)

R1	47 Ohm
R2	100 Ohm trimmer
R3	390 Ohm
R4	820 Ohm
R5 – R7	1K
R8	1.8K
R9	2K, +3500ppm/°C thermistor
R10 – R12	2.2K
R13	3K
R14	5.6K
R15 – R21	10K
R22, R23	11K
R24	12K
R25, R26	15K
R27	18K
R28	33K
R29	50K trimmer
R30, R31	56K
R32 – R36	100K
R37, R38	100K trimmer
R39 – R44	100K linear potentiometer
R45	120K
R46	300K
R47	330K
R48, R49	1M
R50	1.5M
R51	2.2M
R52	3.3M

CAPACITORS (all are 16V or better)

C1	100pF disk
C2	0.001µF mylar
C3	3300pF polystyrene
C4 – C9	0.01µF disc
C10	0.22µF mylar
C11, C12	10µF electrolytic

SEMICONDUCTORS

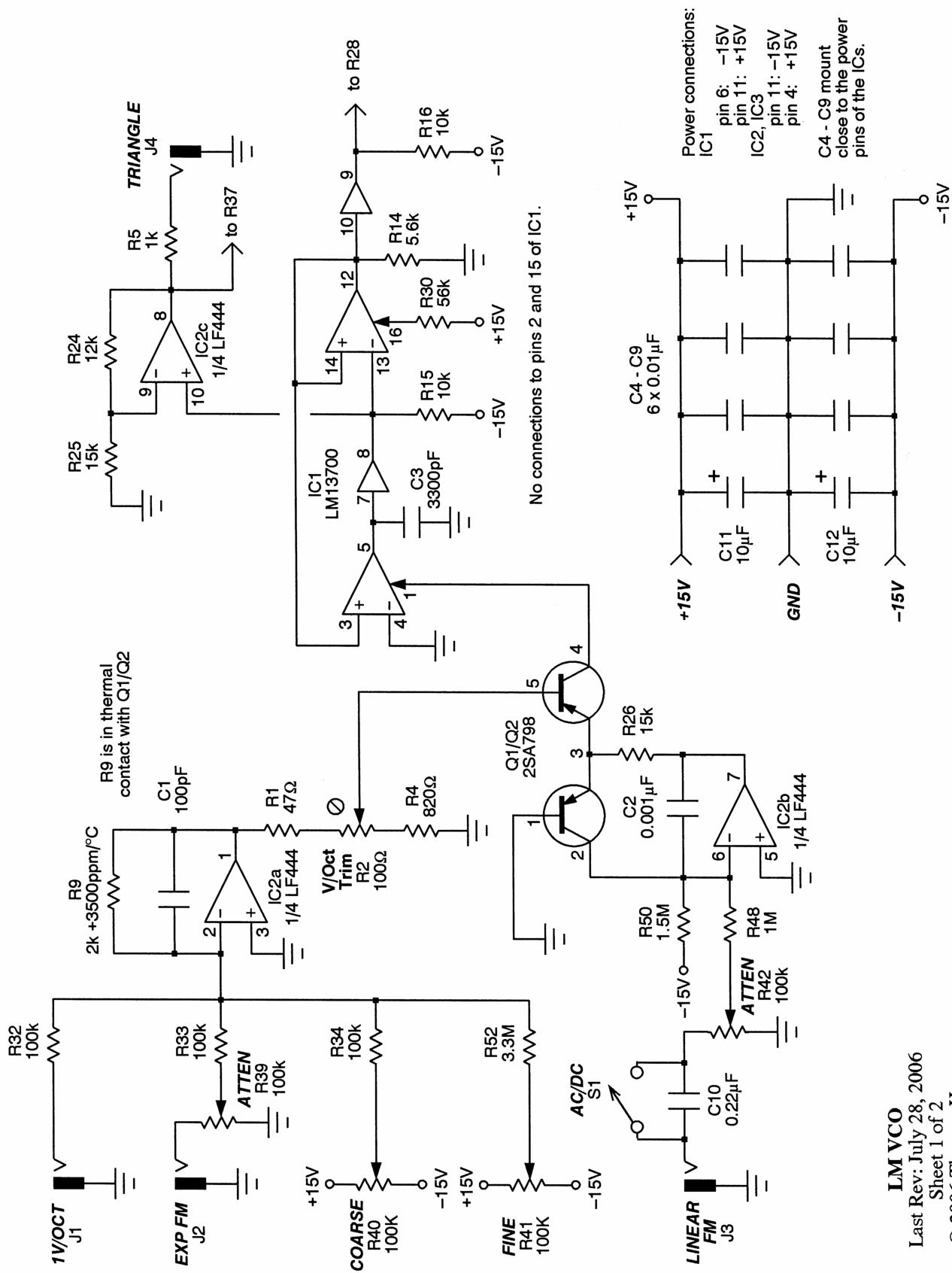
Q1 / Q2	2SA798 matched transistor pair
Q3, Q4	2N3904
Q5	MPF-102
IC1	LM13700 dual OTA
IC2, IC3	LF444 quad op-amp

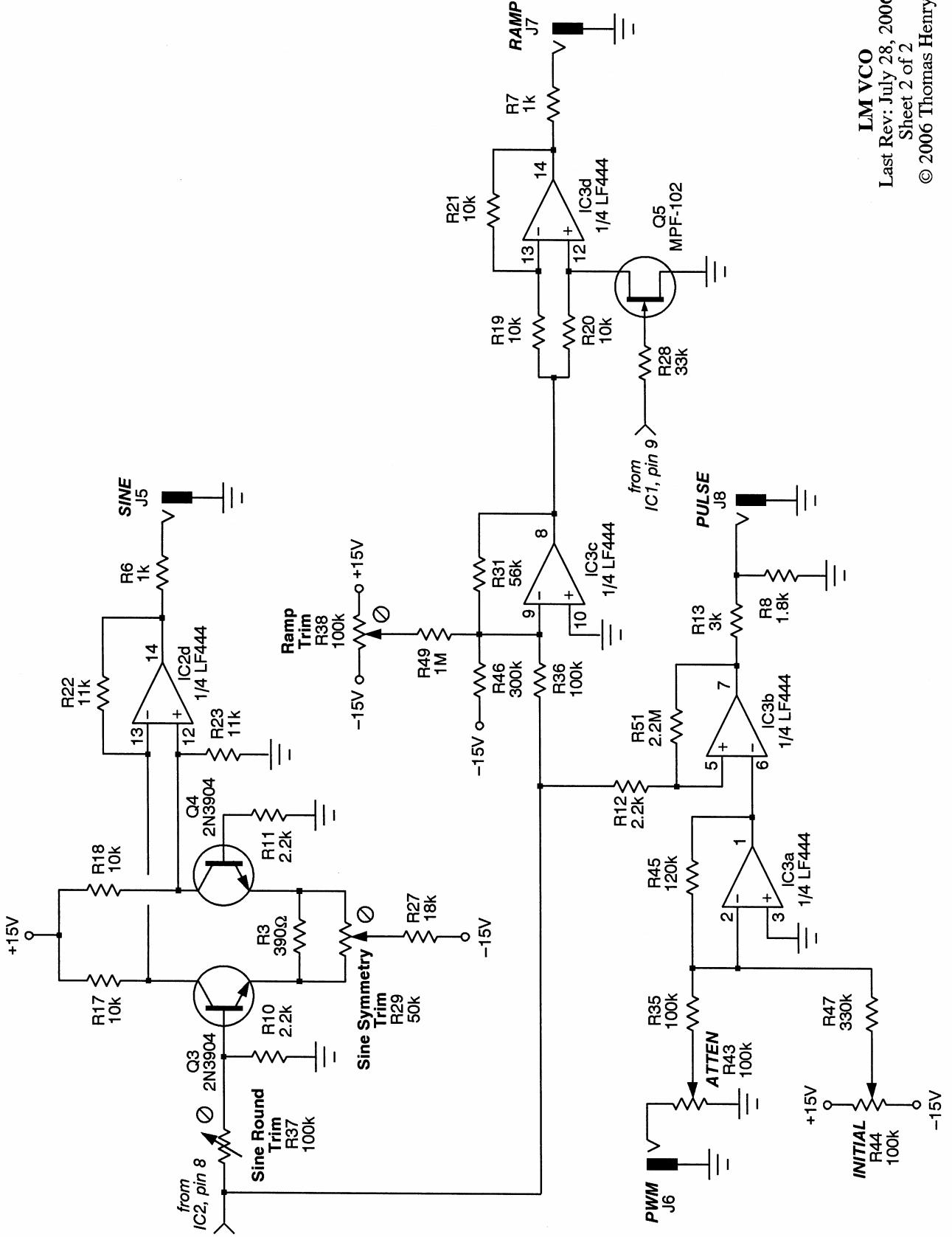
OTHER

J1 – J8	1/4" phone jack, n.o.
S1	SPST toggle switch

MISCELLANEOUS

Printed circuit board, IC sockets, front panel, knobs, wire, solder, heat sink grease, etc.





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5.0 VCF and VCA PARTS LIST

RESISTORS (fixed resistors are 1/4 Watt, 5% values)

R1	500 Ohm trimmer
R2 – R5	510 Ohm
R6 – R9	1K
R10	2K, +3500ppm/°C thermistor
R11	2.7K
R12	10K linear potentiometer
R13	15K
R14 – R17	30K
R18, R19	47K
R20 – R29	100K
R30 – R36	100K linear potentiometer
R37	150K
R38	200K
R39, R40	300K
R41	1M linear potentiometer
R42	3.3M

CAPACITORS (all are 16V or better)

C1, C2	10pF disk
C3	22pF disk
C4, C5	100pF disk
C6, C7	100pF polystyrene
C8 - C11	560pF polystyrene
C12 – C17	0.01µF disc
C18, C19	0.22µF mylar
C20	2.2µF non-polarized electrolytic
C21, C22	10µF electrolytic

SEMICONDUCTORS

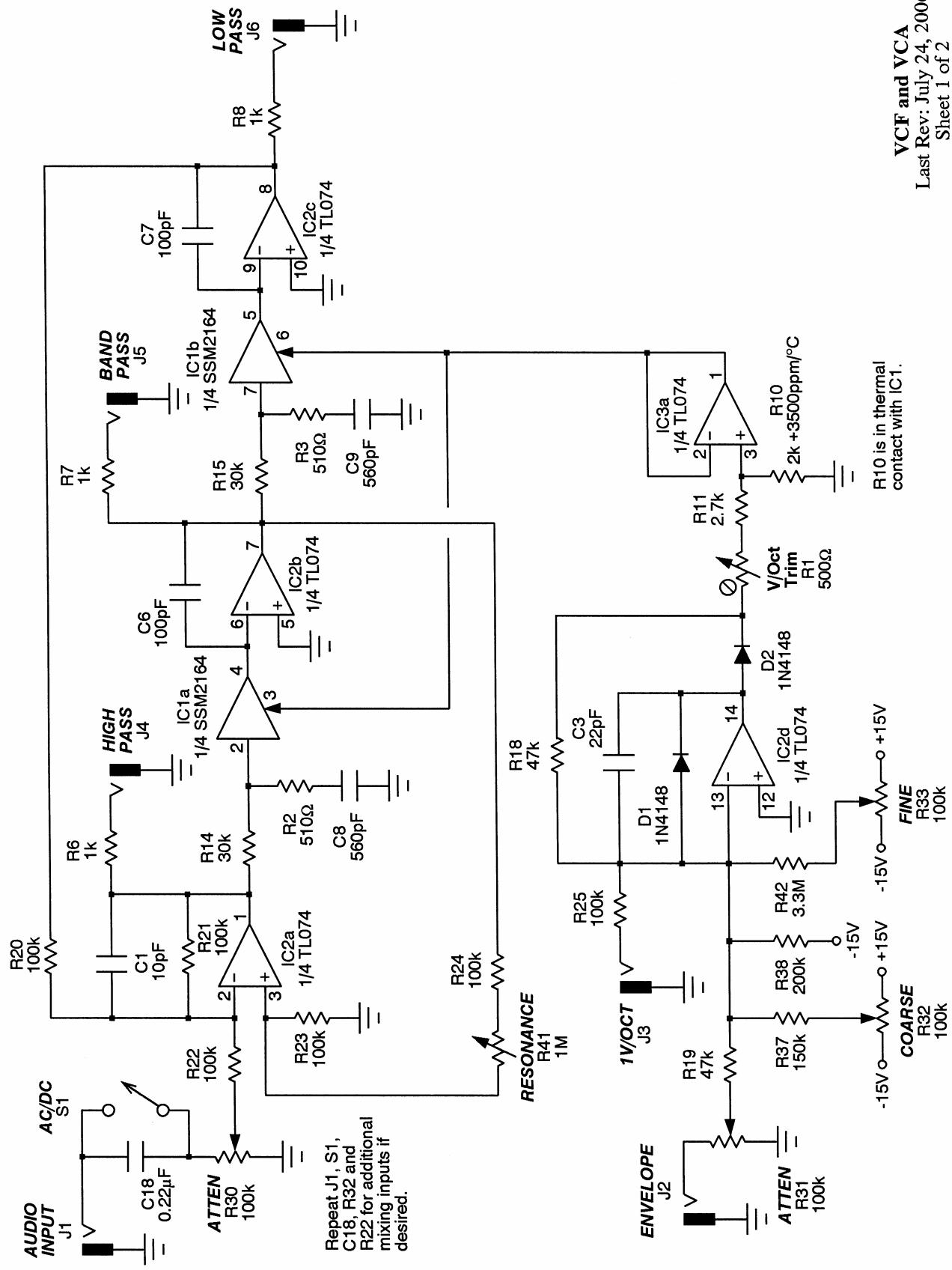
D1, D2	1N4148 diode
IC1	SSM2164 quad VCA
IC2, IC3	TL074 quad op-amp

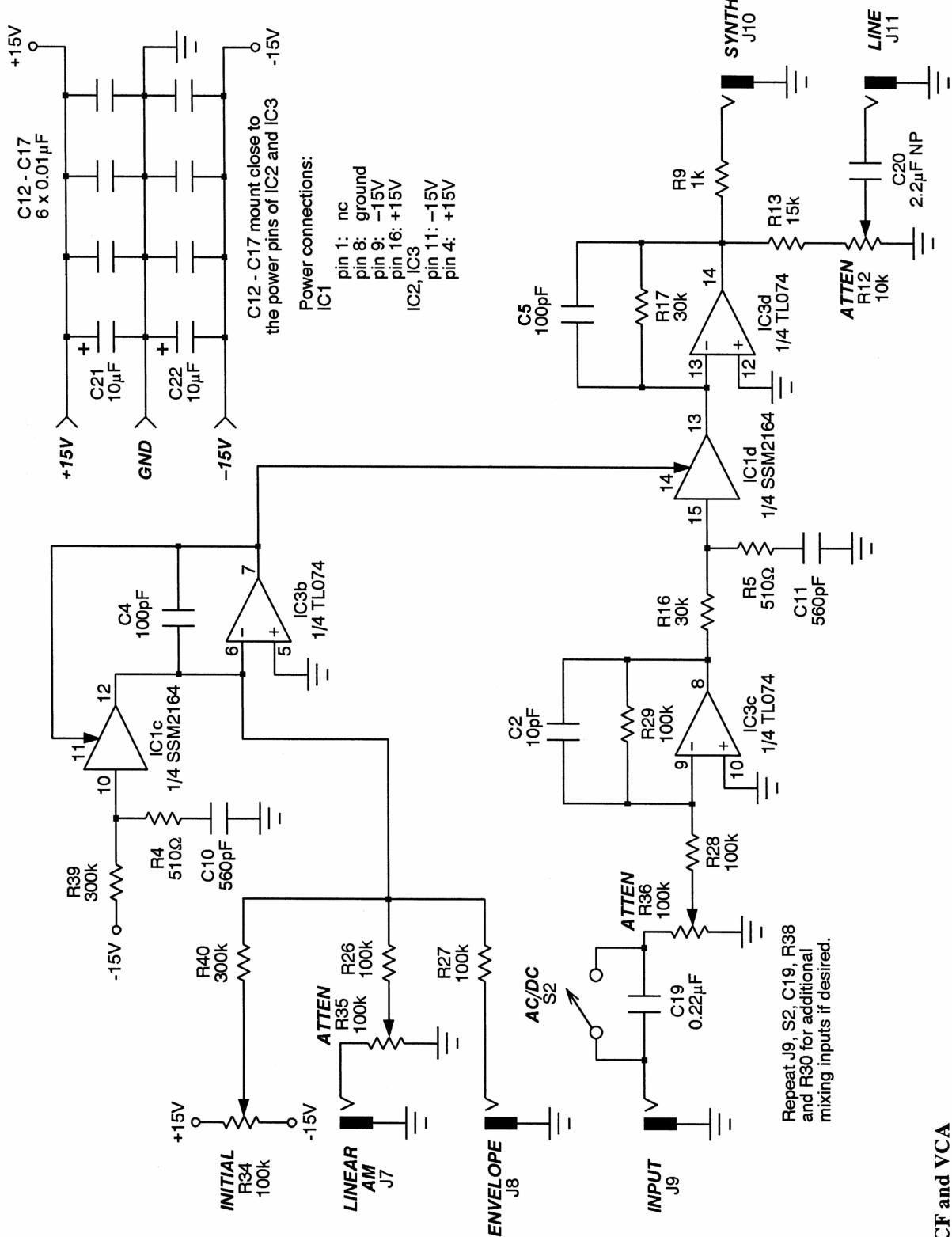
OTHER

J1 – J11	1/4" phone jack, n.o.
S1, S2	SPST toggle switch

MISCELLANEOUS

Printed circuit board, IC sockets, front panel, knobs, wire, solder, heat sink grease, etc.





6.0 LFO PARTS LIST

RESISTORS (fixed resistors are 1/4 Watt, 5% values)

R1	100 Ohm trimmer
R2 – R4	220 Ohm
R5	390 Ohm
R6 – R10	1K
R11, R12	1.2K
R13, R14	1.5K
R15	2K
R16 – R19	2.2K
R20	4.7K
R21	5.6K
R22	6.8K
R23 – R38	10K
R39	15K
R40, R41	20K
R42	22K
R43	27K
R44	39K
R45	56K
R46 – R63	100K
R64 – R67	100K trimmer
R68 – R70	100K linear potentiometer
R71	220K
R72, R73	1M linear potentiometer
R74, R75	2.2M
R76	3.3M
R77	10M

CAPACITORS (all are 16V or better)

C1, C2	47pF disk
C3, C4	470pF disk
C5, C6	0.01µF mylar
C7 – C16	0.01µF disk
C17	1µF electrolytic
C18	1µF non-polarized electrolytic
C19 – C21	4.7µF electrolytic
C22, C23	10µF electrolytic

SEMICONDUCTORS

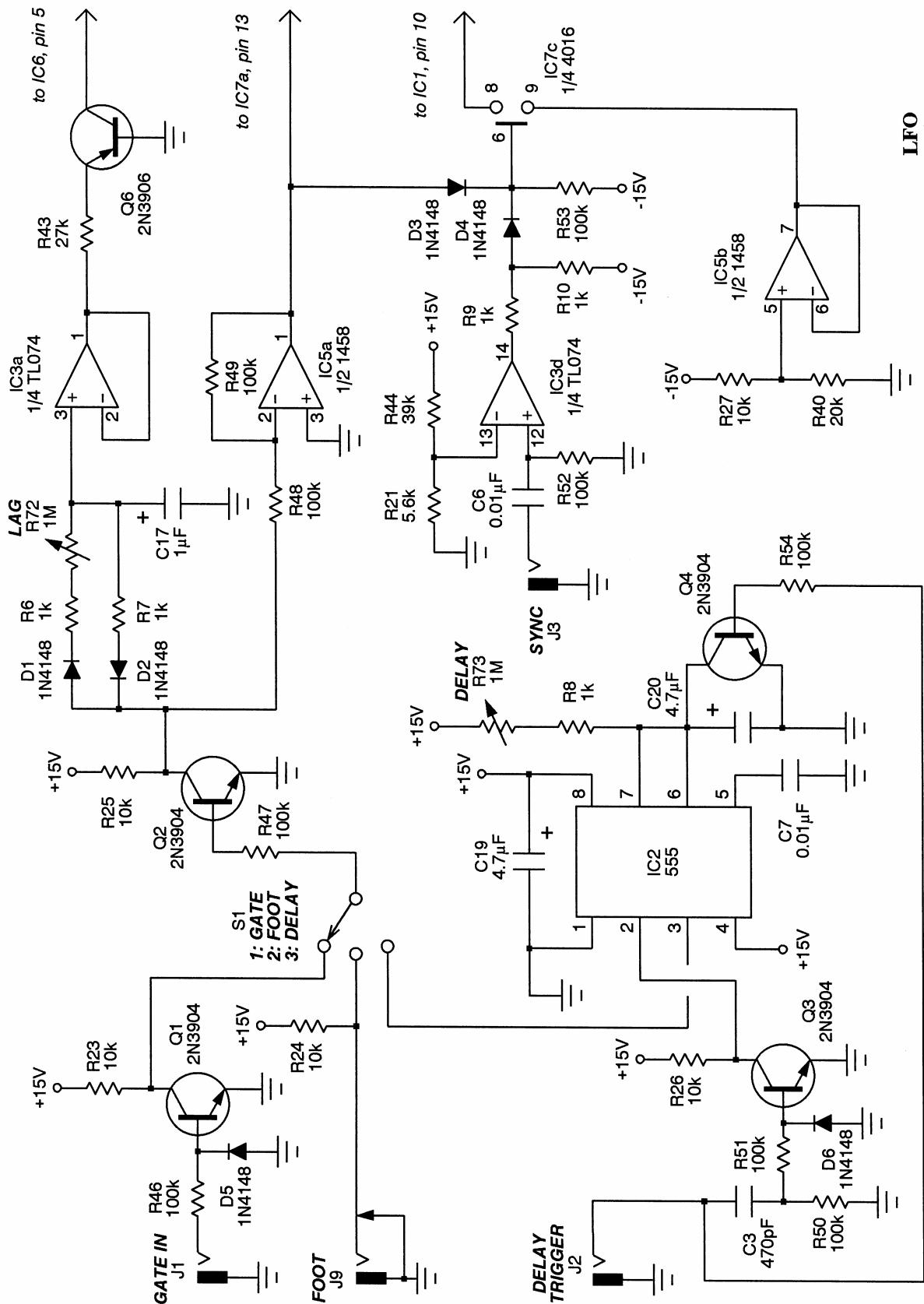
D1 - D11	1N4148 diode
D12	Bi-colored LED
Q1 – Q5	2N3904
Q6 – Q8	2N3906
IC1	8038 function generator
IC2	555 timer
IC3, IC4	TL074 quad op-amp
IC5	1458 dual op-amp
IC6	3080 OTA
IC7	4016 quad CMOS switch

OTHER

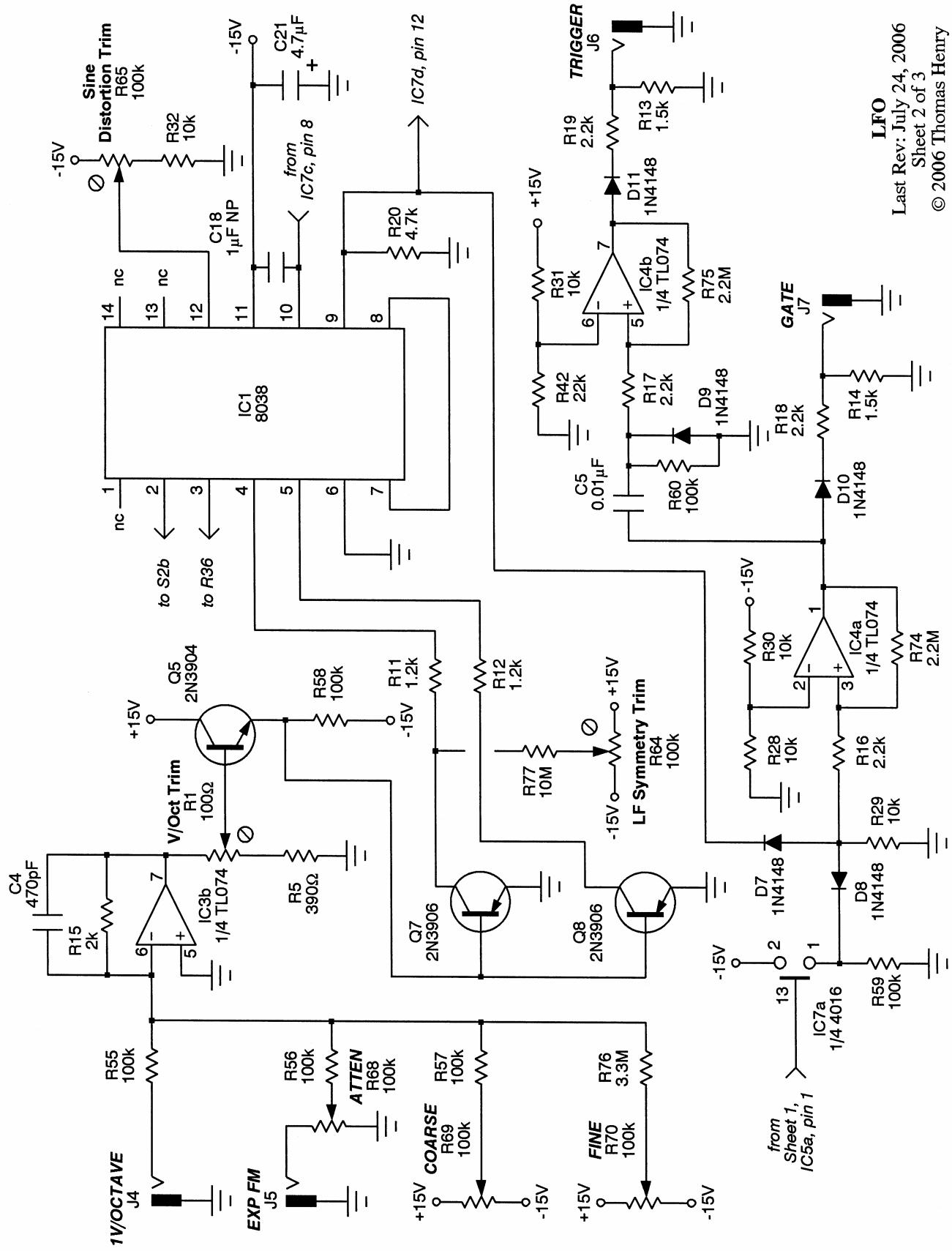
J1 – J8	1/4" phone jack, n.o.
J9	1/4" phone jack, n.c.
S1	SP3T rotary switch
S2	DP3T rotary switch
S3	SPDT toggle switch

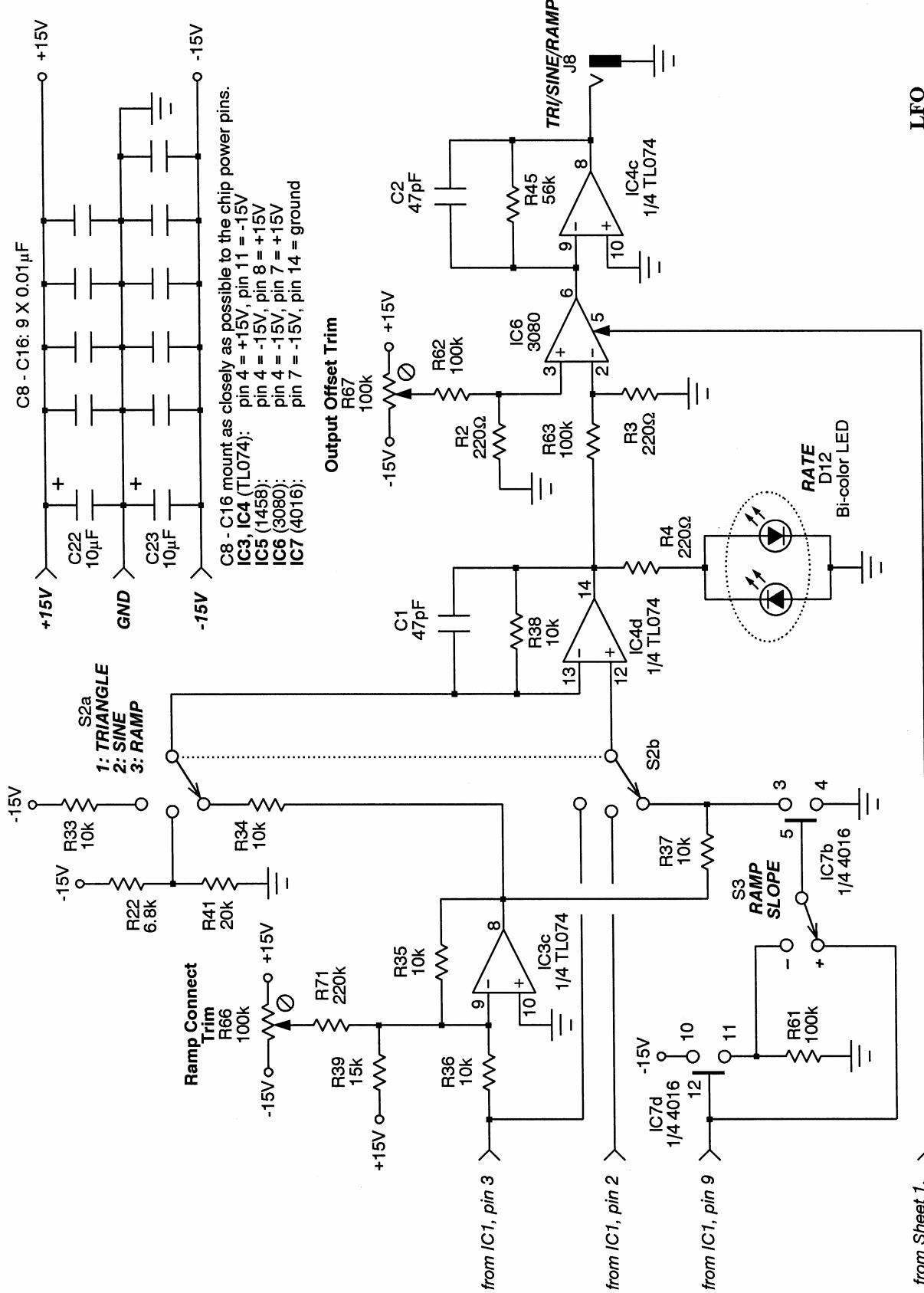
MISCELLANEOUS

Printed circuit board, IC sockets, front panel, knobs, wire, solder, etc.



LFO
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from Sheet 1,
Q6

LFO

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7.0 SAMPLE AND HOLD PARTS LIST

RESISTORS (fixed resistors are 1/4 Watt, 5% values)

R1	10K
R2, R3	100K
R4	100K linear potentiometer
R5	1M
R6	1M linear potentiometer

CAPACITORS (all are 16V or better)

C1	0.001µF mylar
C2, C3	0.1µF mylar
C4, C5	10µF electrolytic

SEMICONDUCTORS

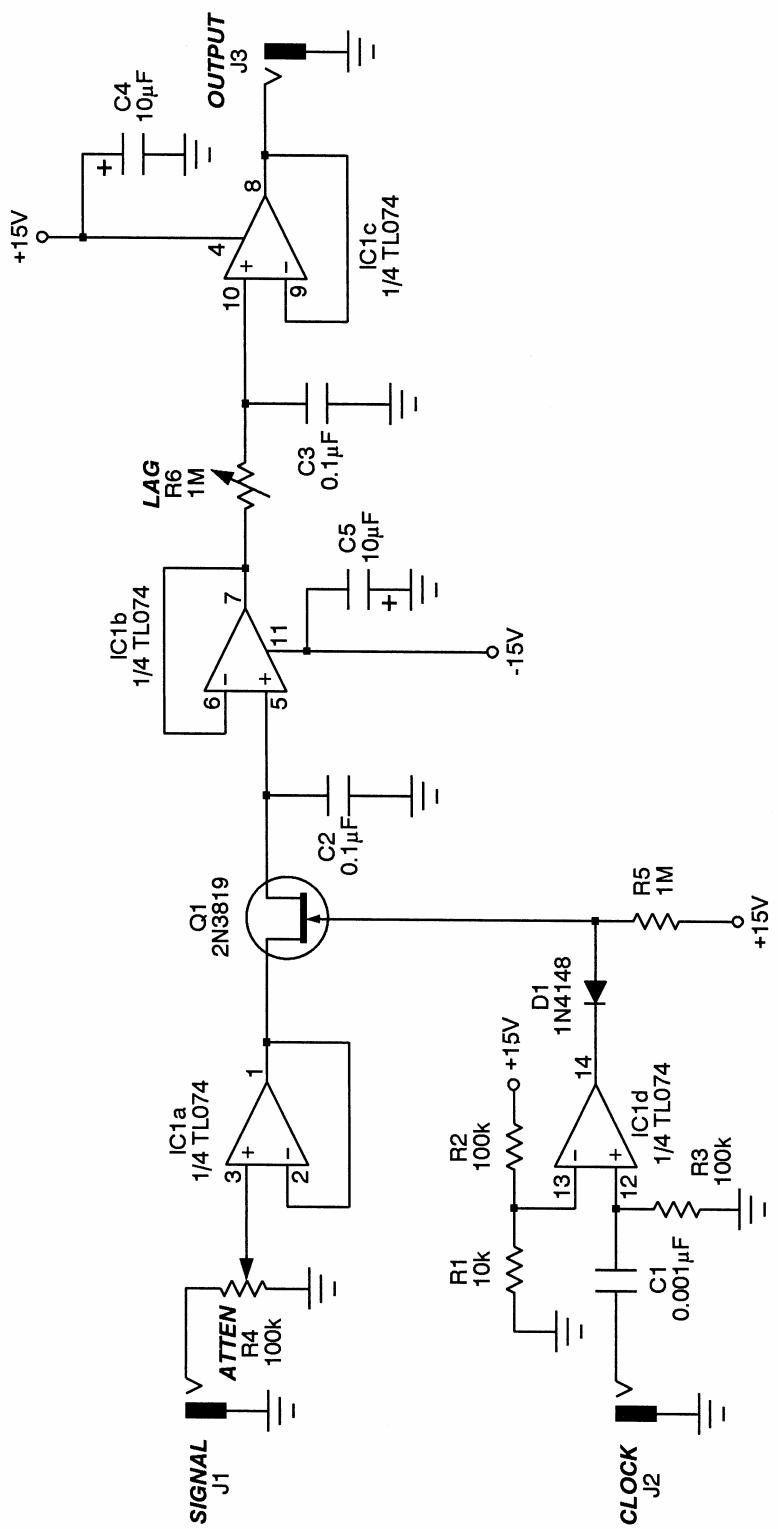
D1	1N4148 diode
Q1	2N3819
IC1	TL074 quad op-amp

OTHER

J1 – J3	1/4" phone jack, n.o.
---------	-----------------------

MISCELLANEOUS

Printed circuit board, IC sockets, front panel, knobs, wire, solder, etc.



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8.0 VC NOISE SOURCE PARTS LIST

RESISTORS (fixed resistors are 1/4 Watt, 5% values)

R1	51 Ohm
R2	470 Ohm
R3	1K
R4	2K
R5	4.7K
R6 – R8	10K
R9	11K
R10	22K
R11	47K
R12 – R15	100K
R16 – R18	100K linear potentiometer
R19	150K
R20	680K
R21	1.5M

CAPACITORS (all are 16V or better)

C1	100pF disk
C2	150pF polystyrene
C3	470pF polystyrene
C4	0.001μF mylar
C5 – C11	0.01μF disc
C12	0.22μF mylar
C13	4.7μF electrolytic
C14, C15	10μF electrolytic

SEMICONDUCTORS

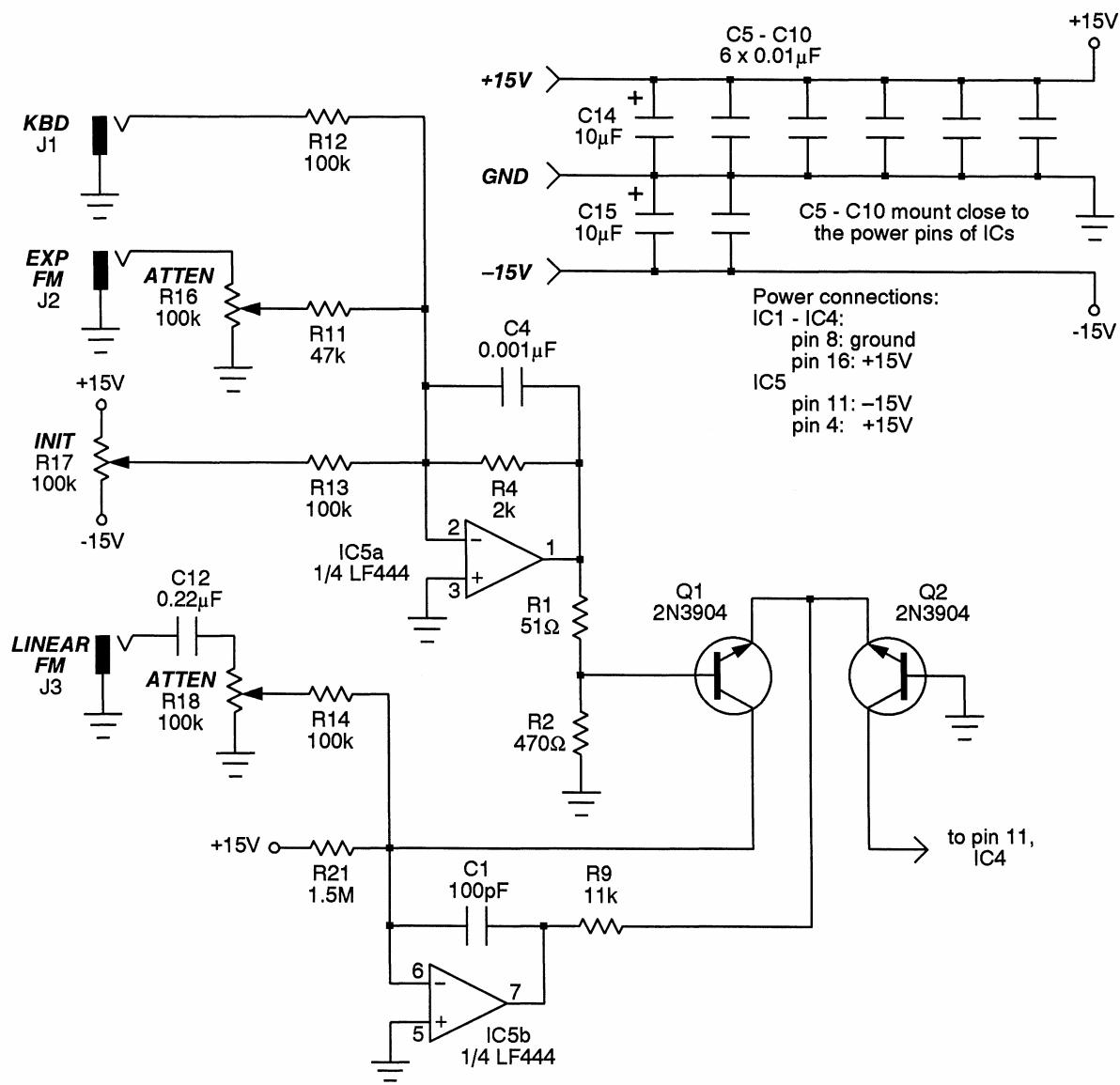
D1	1N4148 diode
Q1 – Q3	2N3904
IC1 – IC3	4015 CMOS shift register
IC4	4046 phase locked loop
IC5	LF444 quad op-amp

OTHER

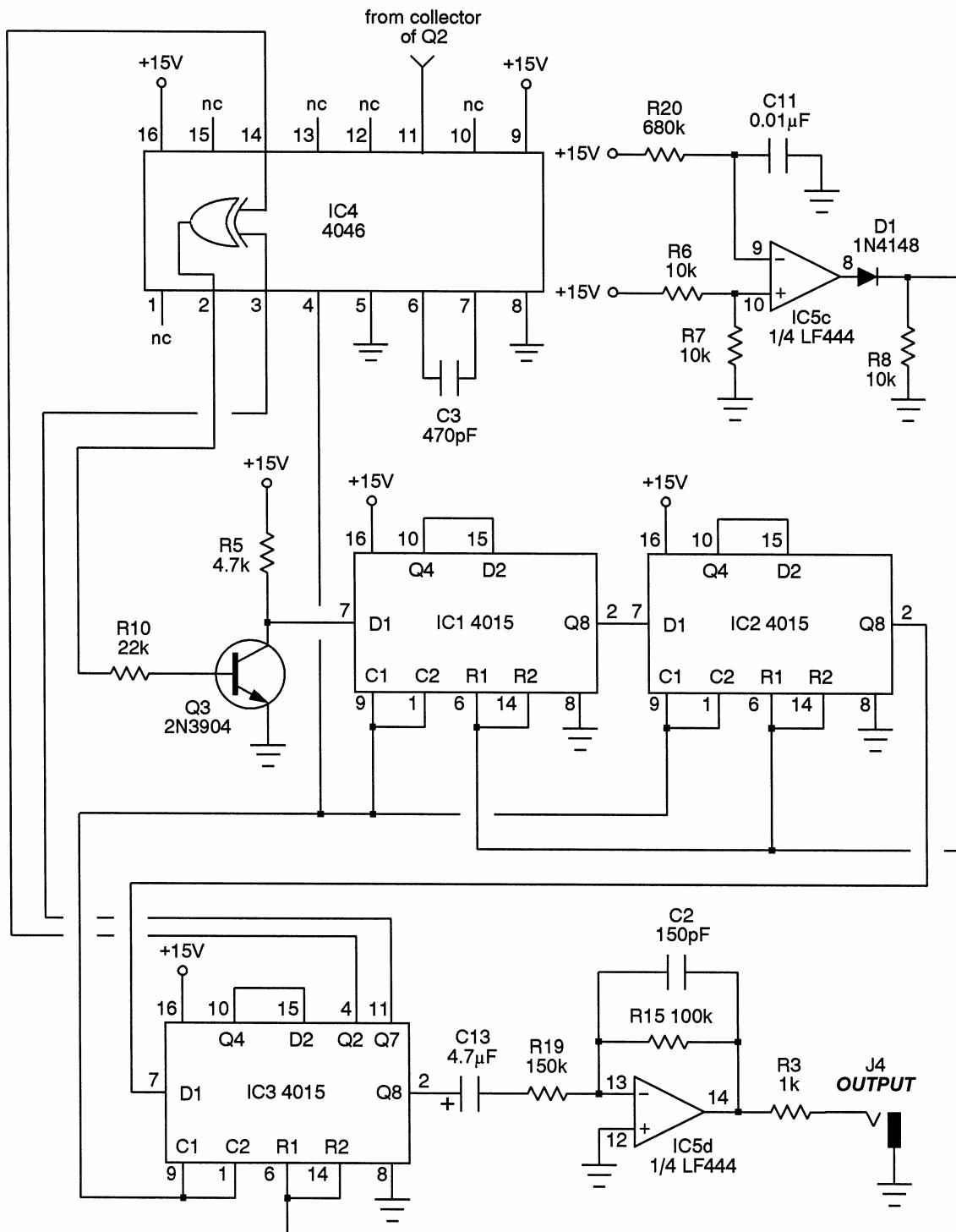
J1 – J4 1/4" phone jack, n.o.

MISCELLANEOUS

Printed circuit board, IC sockets, front panel, knobs, wire, solder, etc.



VC NOISE SOURCE
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VC NOISE SOURCE
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 Sheet 2 of 2
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9.0 VC PHASE SHIFTER PARTS LIST

RESISTORS (fixed resistors are 1/4 Watt, 5% values)

R1	51 Ohm
R2 – R5	220 Ohm
R6	470 Ohm
R7	1K
R8	2K
R9 – R12	15K
R13	47K
R14 – R28	100K
R29 – R32	100K linear potentiometer
R33	500K linear potentiometer
R34 – R37	2.2M

CAPACITORS (all are 16V or better)

C1	10pF disk
C2 – C5	470pF polystyrene
C6	0.001μF mylar
C7 – C14	0.01μF disc
C15, C16	0.22μF mylar
C17, C18	10μF electrolytic

SEMICONDUCTORS

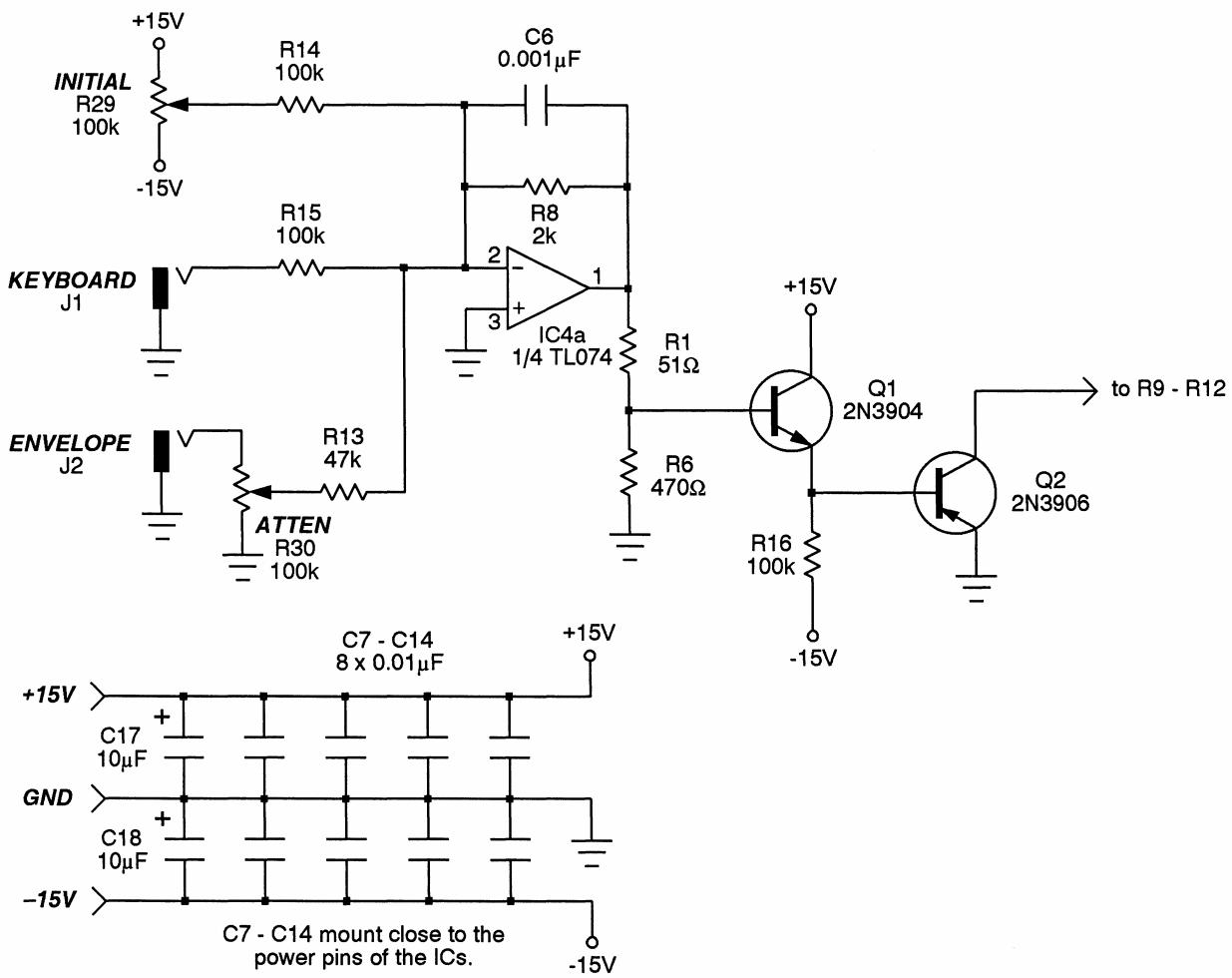
Q1	2N3904
Q2	2N3906
IC1, IC2	LM13700 dual OTA
IC3, IC4	TL074 quad op-amp

OTHER

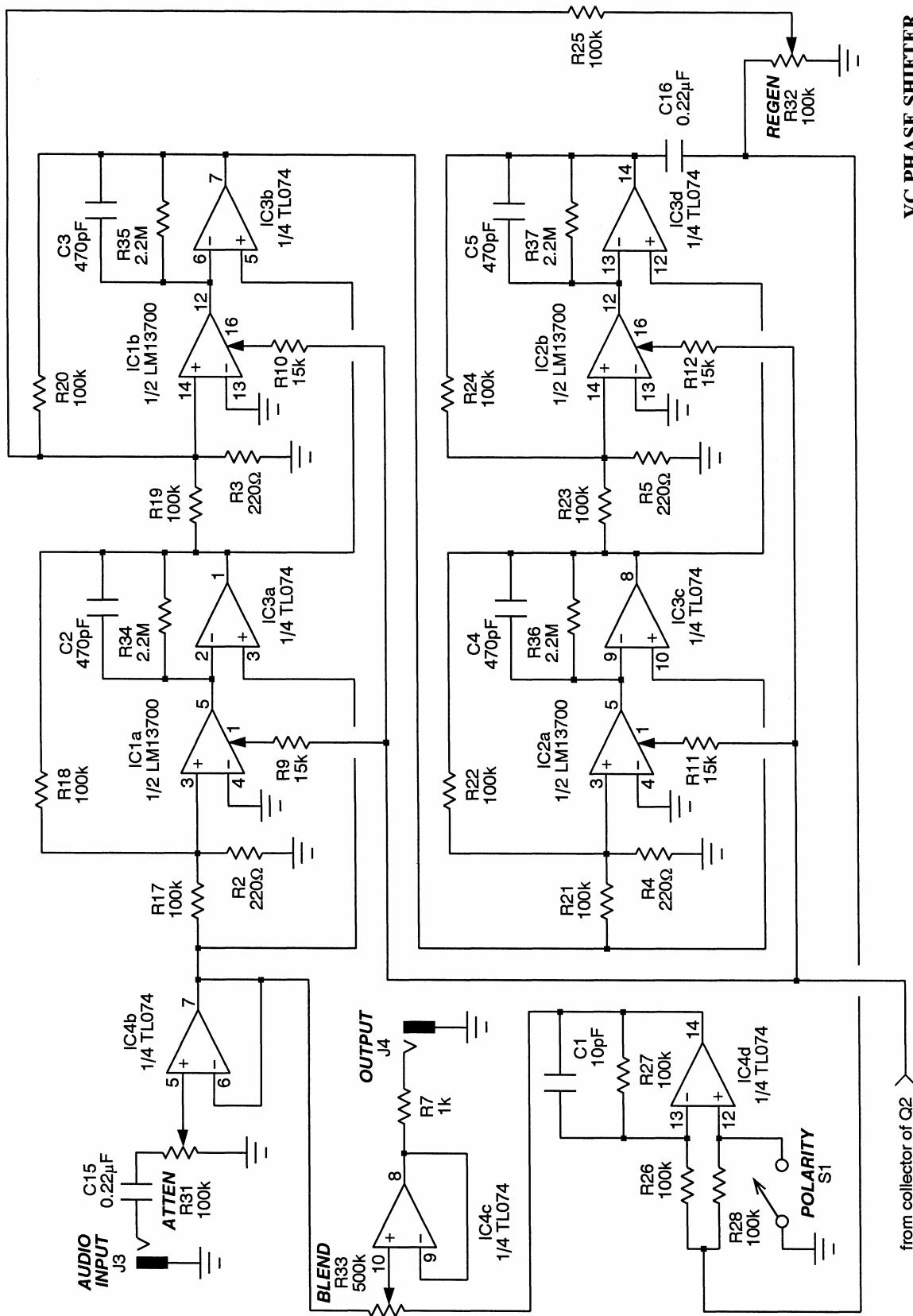
J1 – J4	1/4" phone jack, n.o.
S1	SPST toggle switch

MISCELLANEOUS

Printed circuit board, IC sockets, front panel, knobs, wire, solder, etc.



There is no connection to
pins 2, 7, 8, 9, 10 and 15 of
IC1 and IC2.



VC PHASE SHIFTER
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