

Dirty Electronics: ICA Solder a Score (4th ed.)

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Solder a Score continues with many of the themes I have been developing in Dirty Electronics. These include creating an artistic environment for shared experiences, exploring the boundaries between artwork and circuit board, and asking the question: "What is an instrument?"

The idea for the 'instrument' for Solder a Score was to create a modular system for the Lower Gallery of the ICA - a large white cube-like space - where up to one hundred modules could be connected and played by a large group. I also wanted to use different materials - printed circuit board, wood and scrap metal - and incorporate a variety of building skills.

The circuit is based around the common electronics building block, the operational amplifier. With amplification and gain comes the potential for distortion, noise and oscillation. Two op amps in a dual package are routed in various feedback configurations. The circuit is controlled through touch electrodes and a dual photocoupler. The design also incorporates two simple resistor capacitor (RC) low pass filters. These are controlled by switches 1 and 2 of SW3-DIP (switches 3 and 4 of this DIP switch are left blank).

The signal can be sent using connectors and ribbon cable from one module to control and modulate the sound of another module, thus creating the potential for a complex web of sound synthesis. Each module may also run/be played as a standalone device.

The instrument is designed for both beginners and more advanced builders, and encapsulates two key functions on one circuit board: touch control and sound generation, and a sequencer/pulser.

The sequencer, more accurately a pulse generator, is based around cascading NAND gates. Adjustment to switches (SW4-DIP) and trimpots enable different sequences and patterns to be generated. The sequencer may also be configured in a feedback loop to trigger itself or connected to other modules to create different rhythms (see Appendix 2). The instrument is switched on and off by SW1.

Features

Feedback, Photocoupler Touch Circuit, Noise, Distortion, Filter, Sequencer/Pulser, Modular Connectivity, Jack Output

Playing the Instrument

Find your own way to play the instrument. Some tips. The touch electrodes are predominantly grouped in pairs: see touch control layout (Appendix 2). For example, lick your fingers and touch electrodes A and B: the moister the fingers the more responsive the instrument. Too much moisture will cause the instrument to sound when not touched. The sound will cease when the saliva on the touch controls has dried. The greater pressure on the touch pads the lower the pitch. Two manuals/groupings (left/right hand) are used to control the two stages of the op amp. Whilst touching controls A and B, lick the fingers of the other hand and touch electrodes F and G. The two op amp feedback networks should now modulate each other creating a more complex sound. E and J are optional touch controls and, when used in conjunction with the other electrodes, modify the timbre of the instrument.

The sequencer can be switched on and off independently (SW2) to automate the playing of the instrument. The four trimpots

on the left of the instrument control the speed/frequency of four NAND gates whose outputs modulate each other to create a single sequence of pulses. A second signal is taken midway through the sequence (after the second gate, and therefore a different pattern) and sent to the other op amp stage. The two trimpots on the right of the instrument control the mix of signals sent from the sequencer to the op amp stages. It is possible to use the touch electrodes and the sequencer simultaneously.

Reference

Carter, Bruce. "A Single-Supply Op-Amp Circuit Collection," *Texas Instruments, Application Report, SLOA058*, November 2000

Collins, Nicolas. *Handmade Electronic Music: The Art of Hardware Hacking*. New York [etc.]: Routledge, 2006

Horowitz, Paul and Hill, Winfield. *The Art of Electronics*. 2nd Edition, Cambridge University Press, 1989.

Lancaster, Don. *CMOS Cookbook*. Indianapolis: H.W. Sams, 1977

Mancini, Ron. "Single-supply op amp design," *Analog Applications Journal*, November 1999

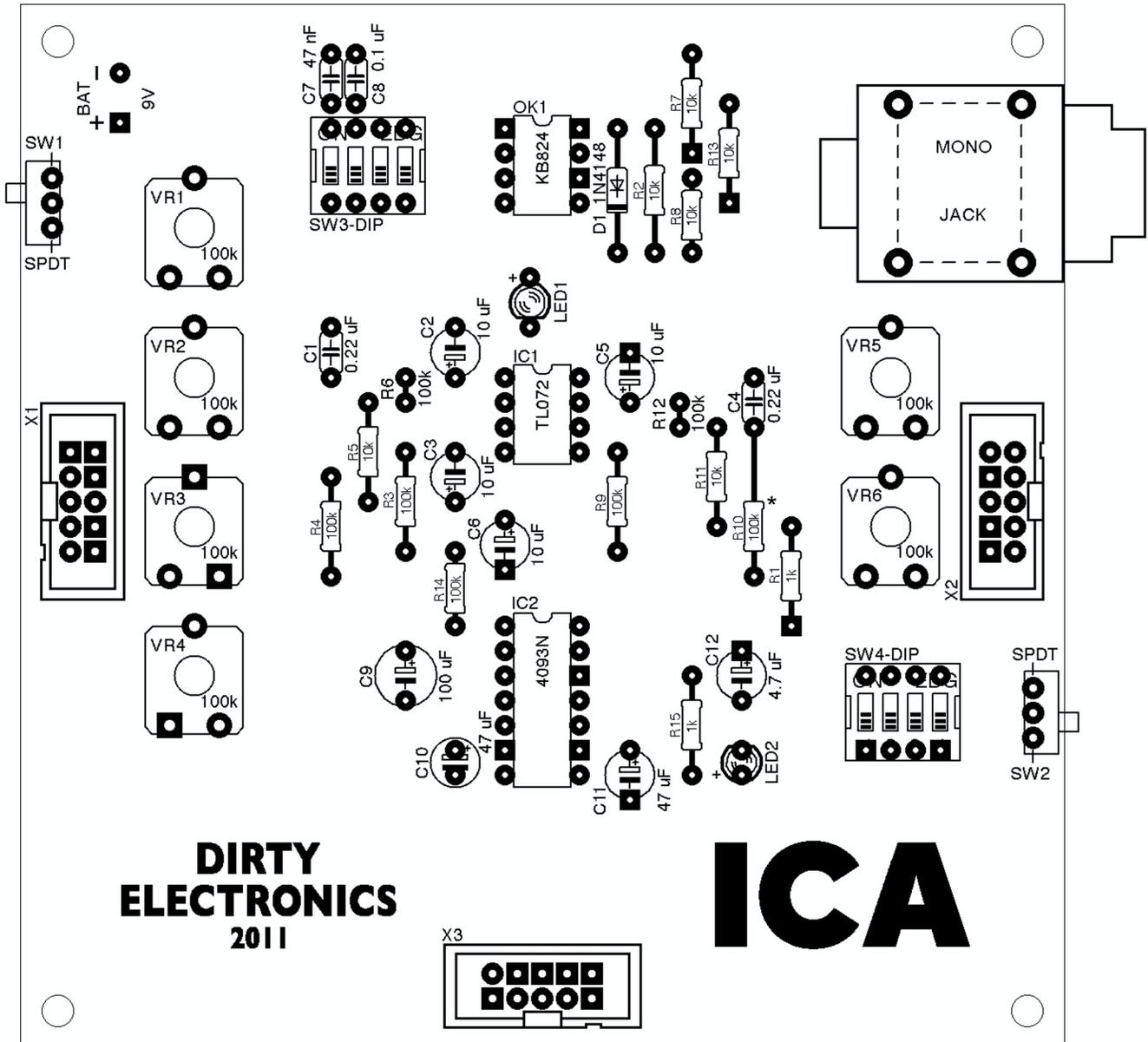
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APPENDIX 1

Component layout



Part List

R1	1k (br/blk/blk/br/br)	R15	1k	LED1	(3mm)	VR5	100k
R2	10k (br/blk/blk/rd/br)	C1	0.22 uF	LED2	(3mm)	VR6	100k
R3	100k (br/blk/blk/org/br)	C2	10 uF	IC1	TL072 Op amp	X1	IDC Header
R4	100k	C3	10 uF	IC2	4093N	X2	IDC Header
R5	10k	C4	0.22 uF	OK1	KB824 Photo.	X3	IDC Header
R6	100k	C5	10 uF	JACK	1/4" MONO	BAT	PP3 Bat clip
R7	10k	C6	10 uF	SW1	SPDT	BAT	9V
R8	10k	C7	47 nF	SW2	SPDT		
R9	100k	C8	0.1 uF	SW3	DIP		
R10	100k	C9	100 uF	SW4	DIP		
R11	10k	C10	47 uF	VR1	100k		
R12	100k	C11	47 uF	VR2	100k		
R13	10k	C12	4.7 uF	VR3	100k		
R14	100k	D1	1N4148	VR4	100k		

* R10: the top facing leg of the resistor bridges its original hole and is soldered directly (top side of board) to the bottom facing leg of capacitor C4.

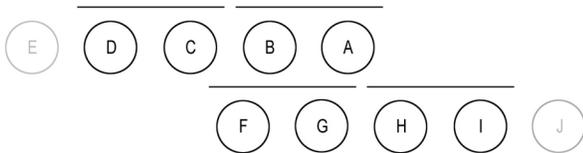
APPENDIX 2

Mounting the printed circuit board (PCB) and making the touch electrodes

The original ICA Solder a Score was mounted on a 10 x 10 inch square 9mm birch plywood finished in Danish oil. The touch electrodes were cut from tin cans using tin snips and fixed to the plywood with pins.

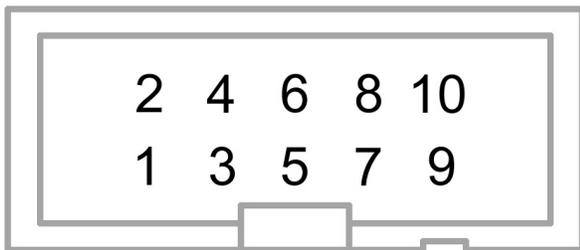
The PCB may be fixed to any hard surface, and a variety of conductive materials and objects can be used for the electrodes: for example, coins, bottle tops, washers, etc.

Suggested touch control layout



E and J connect to ground and are optional. Touching these electrodes produce a slight variation in timbre.

IDC Header pin layout



Touch IDC

A	1 (Group 1)
B	3
C	4
D	9
E	5
F	2 (Group 2)
G	10
H	7
I	8
J	6

These two groups correspond to the left and right hand.

Solder the ribbon cable to the touch electrodes. NOTE THE ORDER!

Inter-connection IDC

Ribbon cable: number 1 is marked red

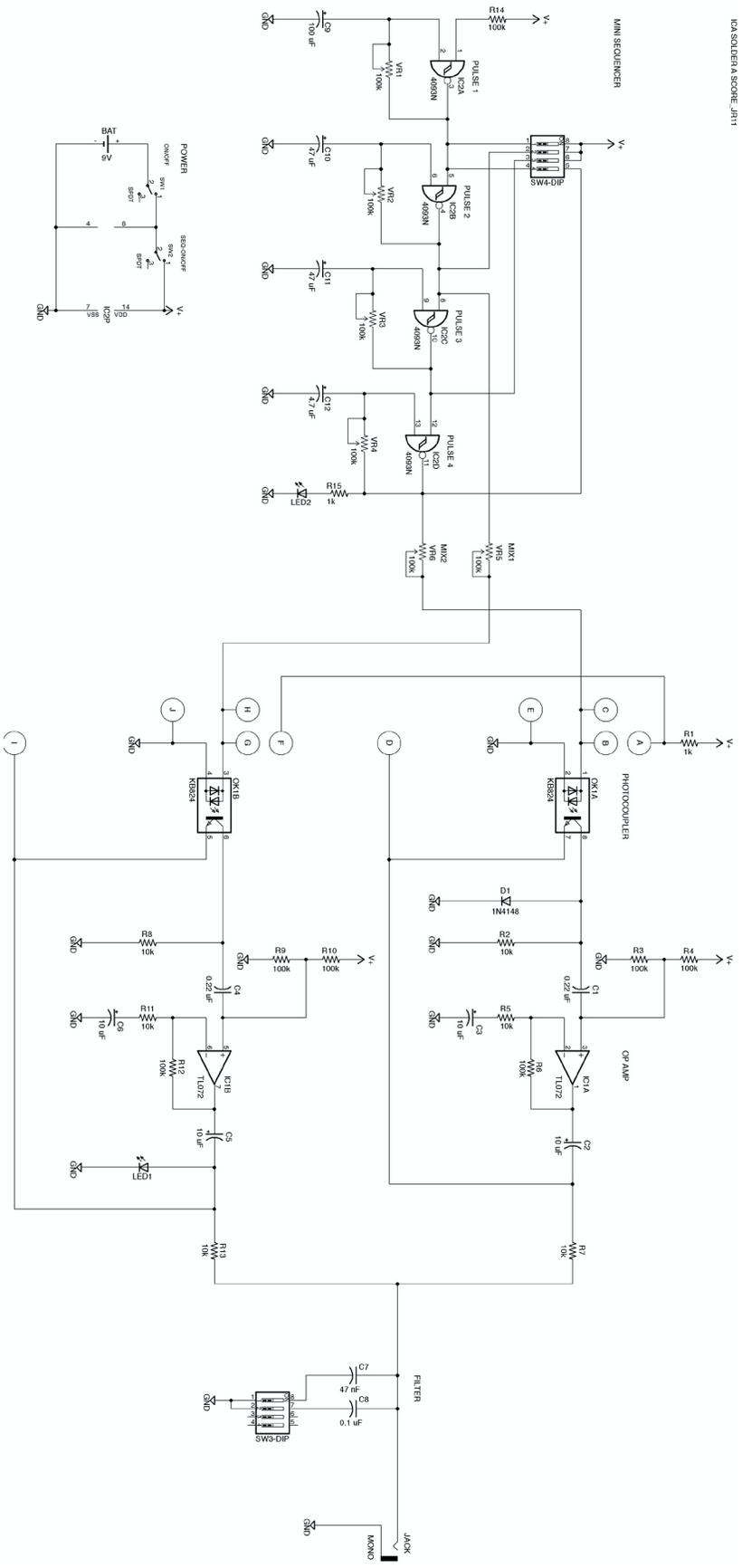
1	power supply +
2	op amp input IC1A
3	-
4	op amp input IC1B
5	-
6	-
7	-
8	sequencer sync
9	-
10	power supply -

The ICA Solder a Score works as a standalone instrument, although it may be connected to other ICA Solder a Score instrument/modules. NOTE: in this configuration make sure the inter-connection IDC cable is correctly connected: for example, pin 1 to pin 1.

APPENDIX 3

Schematic: ICA Solder a Score

ICA SOLDER A SCORE JH11

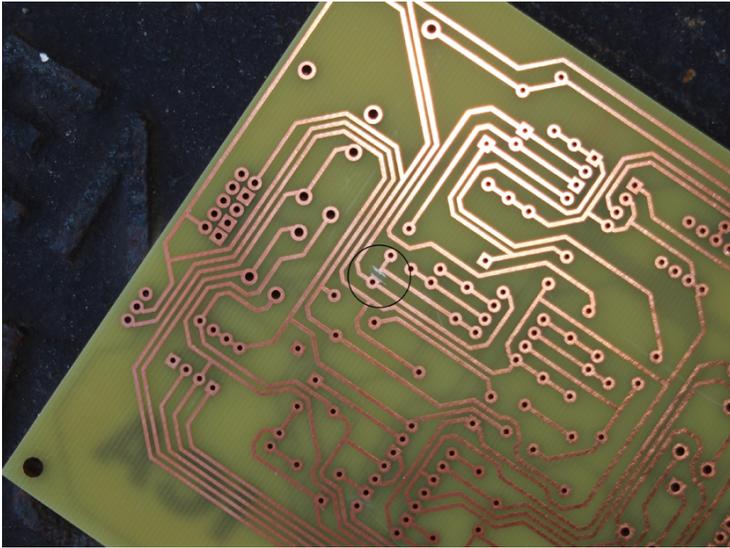


Note: this schematic does not show the IDC connections

APPENDIX 4: PCB MOD

The Dirty Electronics ICA Solder a Score

Removal of track (bottom side)



R10: the top facing leg of the resistor bridges its original hole and is soldered directly (top side of board) to the bottom facing leg of capacitor C4.

