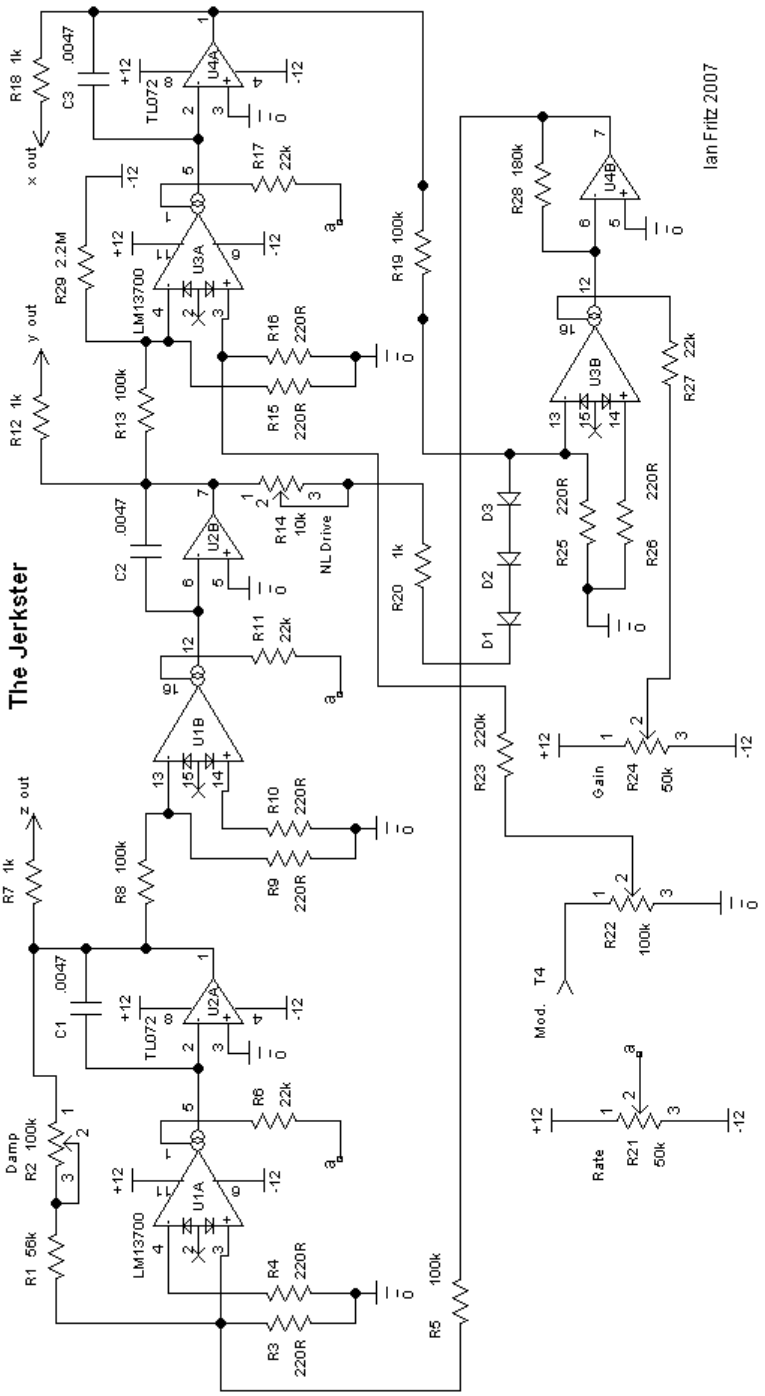
The Jerkster Chaos Circuit

Ian Fritz, April 2007

This circuit produces autonomous chaotic oscillations according to a third-order differential -- or "jerk" -- equation.

Schematic:



Component List:

ICs:

U1, U3	LM13700
U2, U4	TL072 or similar

Resistors (all metal film):

R3, R4, R9, R10	220 Ohm
R15, R16, R25, R26	" "
R7, R12, R18, R20	1 kOhm
R6, R11, R17, R27	22 kOhm (27 kOhm for 15V supplies)
R1	56 kOhm
R5, R8, R13, R19	100 kOhm
R28	180 kOhm
R23	220 kOhm
R29	2.2 MOhm (optional)

Pots:

R14	10 kOhm
R21, R24	50 kOhm
R2, R22	100 kOhm

Caps:

C1, C2, C3	4.7 nF polystyrene or mylar
C4, C5	2.2 mF electrolytic bypass (not on schematic)

Diodes:

D1, D2, D3	1N4148 or other Si switching diode

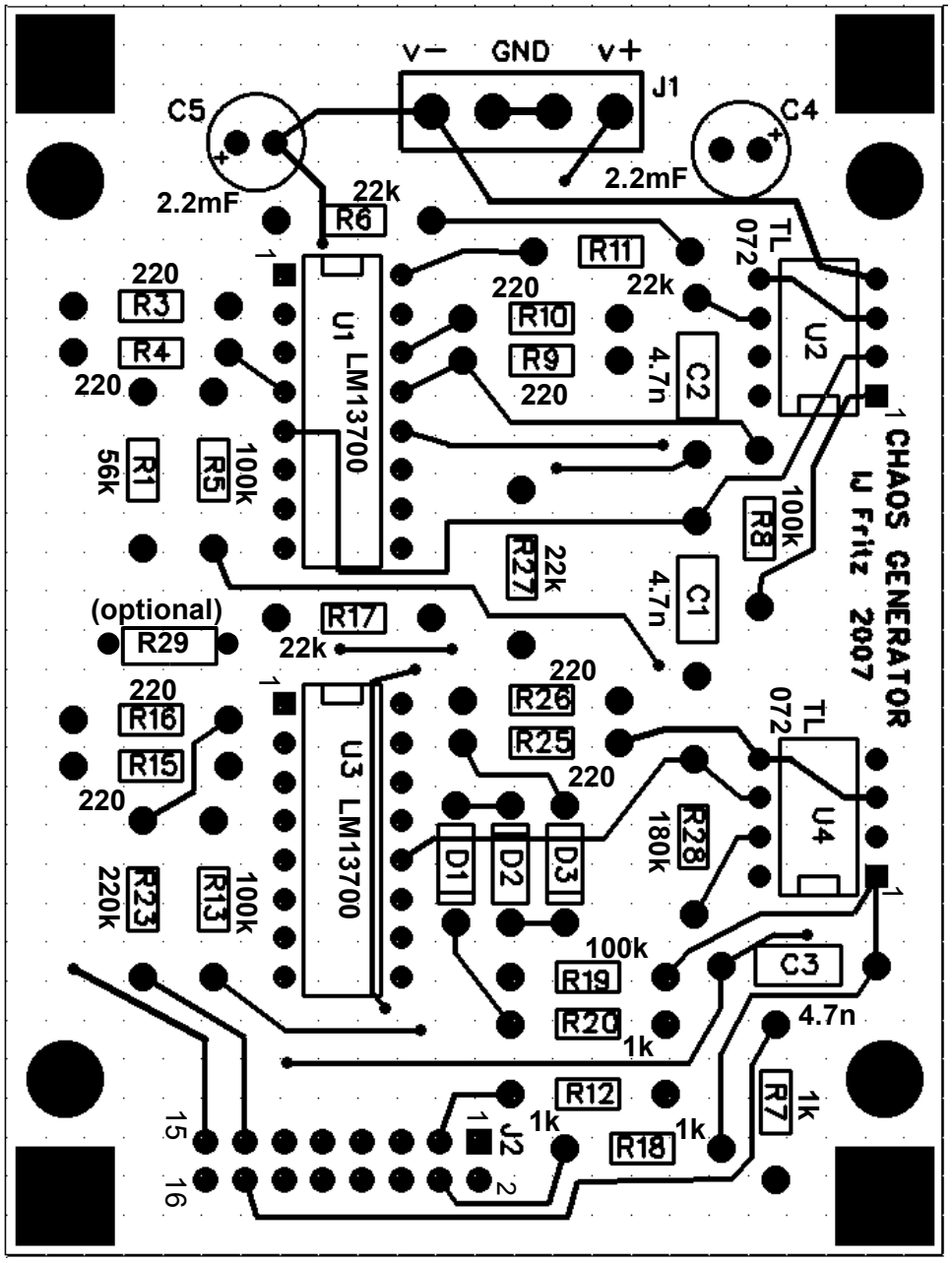
I/O Connector J1 Pinout:

Pin#	**Connection**
1	R14(2&3): NL Drive
3	R14(1): " "
5	R21(2): Rate
7	R21(1), R24(1): +12V
9	R24(2): Gain
11	R21(3), R24(3): -12V
13	R22(2): Mod In
15	R22(3): Gnd
2	Y Output
4	X Output
6	Z Output
14	R2(1): Damping
16	R2(2&3): "

Note: On pots, (1) is CW, (2) is slider, (3) is CCW

Circuit Board:

The board is double sided with overall dimensions of 2.4" x 3.2". The mounting holes are spaced by 2.1" and 2.9". Component placement is indicated on the following drawing:



Notes:

1.) Power: The circuit was developed with +/-12 V supplies, and +/-15 V should work fine also, but it would be wise to increase the OTA protection resistors as indicated in the parts list.

2.) The connection from the Mod In connector to R22 (terminal 1) is to be made on the front panel.

3.) A small number of LM13700 devices have a relatively large offset voltage that causes the signal levels to be quite small. It is recommended to socket these chips and to try various pairs of devices. Signal levels vary with the pattern, but should be several volts in amplitude. If a large enough pattern can not be obtained, or if the chips are not socketed, the optional resistor R29 may be added to increase the signal level. (This resistor bucks the offset voltage.) On the newer boards, R29 is mounted in the marked position on the above diagram. On older boards it is necessary to solder R29 directly to the component pins on the bottom side of the board. The pins are pins 4 and 6 of U3.

4.) The pattern of the chaotic signal changes rapidly with the circuit's operating parameters, especially the Damping and Gain controls. Thus it is strongly recommended that fine adjustment of at least one of these parameters be provided for. This can be done either with multi-turn potentiometers or with added fine-tuning controls. These may be wired in place on the front panel, without any need to connect to the circuit board.

5.) Since the Rate and Gain functions are controlled by OTA's, the two pots for these functions can easily be replaced by standard voltage to current converters to implement external voltage control. Extra mounting holes are provided to allow adding a separate board for this.

6.) The circuit is similar to one described in: AS Elwakil, Chaos, vol. 14 (2004). A more general discussion of jerk systems may be found in: JS Sprott, Chaos and Time-Series Analysis, Oxford (2003).

7.) More details on the design of chaos circuits as related to mathematical systems of differential equations along with other examples of chaotic circuits are posted on my web site: home.comcast.net/~ijfritz/ch_over.htm

8.) Many web resources on chaos theory, circuits and musical applications are available and easily found through standard search engines.