TADD-3 Assembly and Operation Manual

Eight Channel Pulse Distribution Amplifier

Revised: 10 December 2006

Introduction

The TADD-3 is an eight channel pulse distribution amplifier. Its primary purpose is to allow one or two pulse sources, for example, the pulse-per-second ("PPS") signal from a GPS receiver, to drive several loads with high isolation. The input pulse rate can range from as slow as you'd like, up to several megaHertz.

The TADD-3 is designed to be very versatile and offer flexibility in use. The eight outputs consist of six low impedance BNC outputs capable of driving coax lines, and two RS-232 level outputs designed to drive the serial port of a PC. All the outputs can be driven from a single source, or they can be divided into two groups of four, each driven from its own source. Each output can be set to invert the input, or maintain the same polarity.

The input signal(s) can be CMOS or TTL level, or can be routed to a low-jitter comparator that allows the use of other levels. Inputs can be terminated into 1 megohm, 4.7 kilohm, or 50 ohm loads.

The TADD-3 includes a fused and reverse-polarity protected 5 volt regulator. The supply voltage can range from 7 to 24 volts. Current drain will depend on the output loads, but is typically in the range of 60 to 150 milliamps.

See the "Performance" section for further details.

Circuit Description

BNC connectors J1 and J5 are inputs, each of which drives one RS-232 and three low impedance outputs. JP7 optionally straps the two inputs together so that all the outputs can be driven from one input signal.

JP4 and JP16 allow the inputs to be terminated in 50 ohms or 4.7 kilohms (to mimic a TTL load). If neither jumper is selected, the input impedance is 1 megohm.

Lowest delay and jitter occur when the input signal is routed directly to IC3, a 74AC14 Schmitt trigger. However, if the input signal level is too low for TTL compatibility, either or both inputs can be routed to LT1016 high speed comparators. R18 and R21 set the comparator trigger levels; the trigger voltage can be monitored at TP1. JP1 and JP2 select whether input 1 is routed to the comparator or to the TTL level input circuit. JP12 and JP13 do the same for input 2.

Whichever input method is selected, each input signal is routed through two sections of IC3. From there, the signal is routed to the output stages.

Each of the low impedance outputs is formed from three 74AC04 inverter gates (from IC1, IC2, and IC4), paralleled through 47 ohm resistors (SIP resistor packs are used to conserve board space).

The output signal is also routed to a MAX232 RS-232 line driver. The MAX232 outputs go to a pair of 10 pin (2x5) headers which can be used with a ribbon cable and DB-9 connector. By design, the MAX232 has a relatively slow rise time – about 2.5us. Alternative chips, such as the MAX232A or LT1181, can provide a

faster rise time. For example, the LT1181's rise time is about 500ns. This can be helpful to reduce trigger uncertainty, and may also provide more reliable operation if the input signal has a short duration; the faster edge transitions may make it easier for the computer serial port to catch the pulse. The faster chip can be substituted directly for the MAX232; while these chips call for smaller charge capacitors (0.1uF instead of 1uF), they will work fine with the larger capacitors.

A series of jumpers (JP1, JP3, JP5, JP6, JP8, JP13, JP14, and JP17) allow each output stage to be driven by either a normal, or an inverted, signal.

100 kilohm resistors R7, R8, R9, R11, R12, and R13 tie the 74AC04 inputs to ground to avoid excessive current drain that may result if the inputs are allowed to float. Similarly, 1 megohm resistors R2 and R6 tie down the Schmitt trigger inputs (R5 ties down a pair of unused gates in IC3).

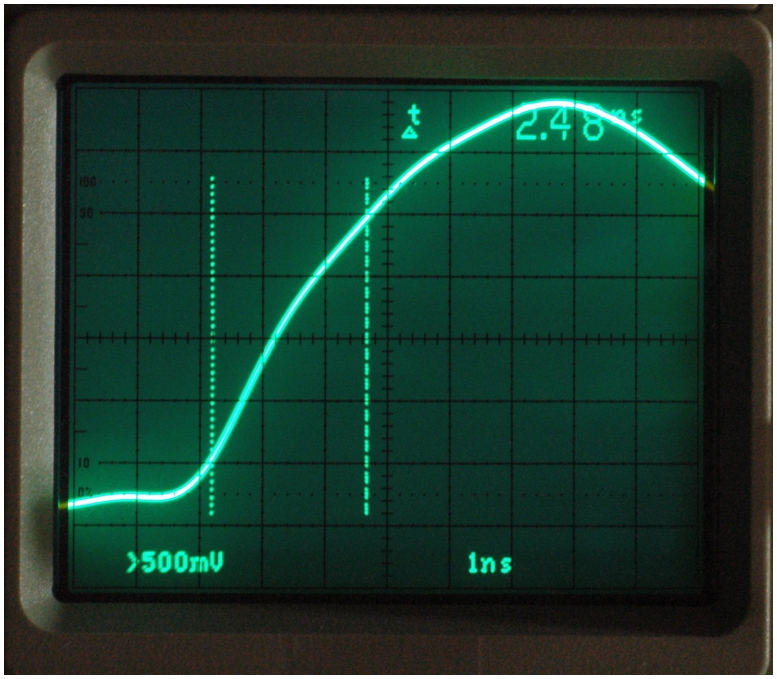
Typical Performance

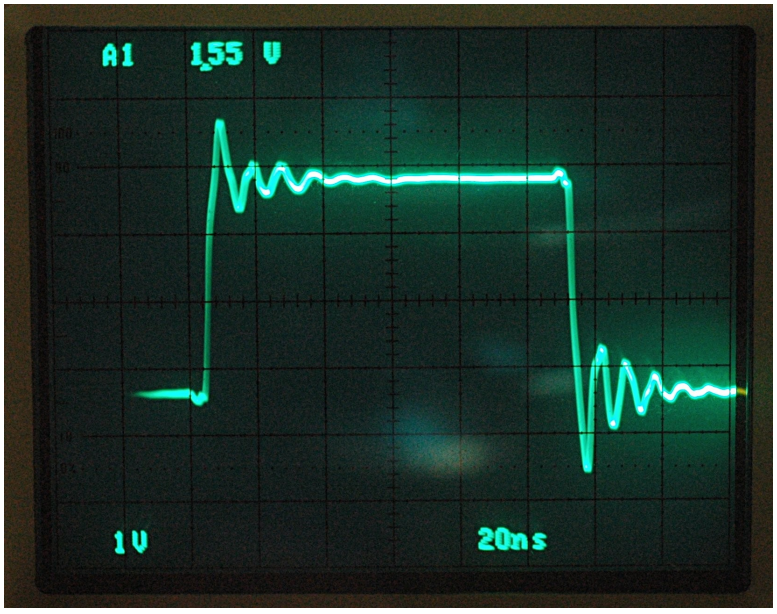
Current Drain

Approximately 65ma @ 13.8 volts, no input signal and no load. Current drain will vary significantly depending on the duty cycle of the input signal (and output signal, if inverted), and the output load. Maximum drain with all six outputs driving 50 ohms is under 250ma.

Output Waveform

(driving 50 ohm load)





Preparation

The TADD-3 kit includes the printed circuit board, one or two tubes containing ICs and sockets, a bag with eight BNC connectors, and __ manila envelopes containing small components. Check to make sure your kit includes all these bits, and check the contents of the envelopes against the parts inventory below.

Refer to the layout diagram for clarification of parts placement. All references to up, down, left, and right assume that you are looking at the PCB with the "TADD-3" text and copyright notice along the right-hand side of the board. All components are mounted on the top of the PC board.

If you plan to mount the TADD-3 using the four corner holes, now is a good time to use the PC board as a template for marking the mounting holes in your enclosure.

Check your soldering iron to be sure the tip is in good condition. The tip should be the small conical tip type and must be clean. If you can't remember when you last replaced the tip, now would be a good time to do so.

All parts should be mounted as nearly flush to the board surface as practical without stressing the lead.

The installation sequence below is arranged logically by component type. You may find it easier to install the parts from lowest profile (e.g., resistors) to highest (e.g., electrolytic capacitors). In any case, don't install the ICs until the end.

Parts Inventory

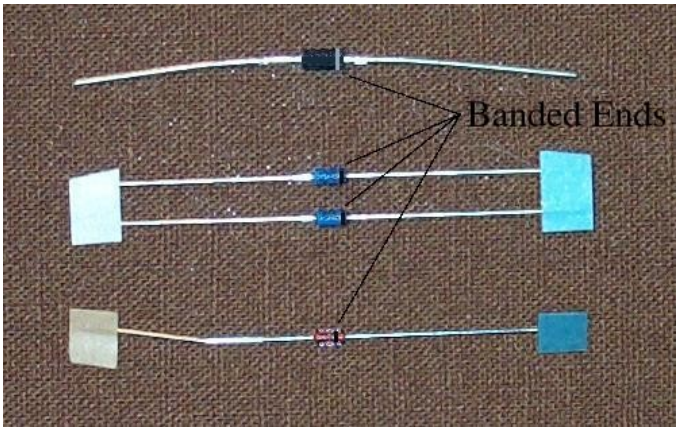
OK?	Qty	Value	Part
	7	0.001uF	C5, C6, C7, C8, C9, C10, C16
	7	0.1uF	C11, C12, C13, C14, C15, C17, C20
	1	0.33uF	C19
	7	1uF	C1, C2, C3, C4, C21, C22, C23
	1	10uF	C18
	1	SA15A TVS	D1
	1	0.5A PICOFUSE	F1
	3	74AC04N	IC1, IC2, IC4
	1	74AC14N	IC3
	1	LM7805	IC8
	2	LT1016	IC5, IC7
	1	MAX232	IC6
	8	BNC	J1, J2, J3, J4, J5, J6, J7, J8
	8	Washer and Nut	--
	2	2-pin header	JP7, TP1
	14	3-pin header	JP1, JP2, JP3, JP4, JP5, JP6, JP8, JP11, JP12, JP13, JP14, JP15, JP16, JP17
	15	Shorting Block	--
	2	10-pin header	SV1, SV2
	1	2-pin Molex header	JP19
	1	2-pin Molex connector and crimp pins	--
	1	1 ohm	R22
	6	47 ohm SIP pack	RN1, RN2, RN3, RN4, RN5, RN6
	2	51 ohm	R3, R14
	2	470 ohm	R1, R10
	4	4.7kohm	R4, R15, R16, R19
	2	10kohm trim pot	R18, R21
	6	100kohm	R7, R8, R9, R11, R12, R13
	5	1Mohm	R2, R5, R6, R17, R20

Resistor Installation

Ok	Procedure
	Install a 1 ohm resistor at R22.
	Solder and clip 2 leads.
	Install 51 ohm resistors at R3 and R14.
	Solder and clip 4 leads.
	Install 470 ohm resistors at R1 and R10.
	Solder and clip 4 leads.
	Install 4.7 kilohm resistors at R4, R15, R16, and R19.
	Solder and clip 8 leads.
	Install 100 kilohm resistors at R7, R8, R9, R11, R12, and R13.
	Solder and clip 12 leads.
	Install 1 megohm resistors at R2, R5, R6, R17, and R20.
	Solder and clip 10 leads.
	Install 47 ohm resistor packs at RN1, RN2, RN3, RN4, RN5, and RN6.
	Solder and clip 36 leads.

Diode Installation

Diodes are polarity sensitive devices. The cathode end of the diode is banded and corresponds to the banded silk-screen legend on the PC board. If you have never worked with these devices, take a look at the photograph showing the banded ends.



Ok	Procedure
	Install a SA15A TVS diode at D1.
	Solder and clip 2 leads.

Fuse Installation

Ok	Procedure
	Install a 0.5 amp PicoFuse at F1.
	Solder and clip 2 leads.

Capacitor Installation

Ok	Procedure
	Install 0.001 uF (102) capacitors at C5, C7, C8, C9, C10, C11, and C16
	Solder and clip 14 leads.
	Install a 0.1 uF (102) capacitors at C6, C12, C13, C14, C15, C17, and C20
	Solder and clip 14 leads.
	Install a 1 uF (101) tantalum capacitor at C1, C2, C3, C4, C21, C22, and C23. Tantalum capacitors are polarized; the positive lead is marked with a "+" and is longer than the negative lead. The + lead of C1, C21, C22, and C23 goes to the wide +5 volt trace. The + lead of C3 goes to ***ground***. The + lead of C2 goes to pin 1 of IC6. The + lead of C4 goes to pin 4 of IC1.
	Solder and clip 14 leads.
	Install a 0.33 uF (334) tantalum capacitor at C19.
	Solder and clip 2 leads.

Electrolytic capacitors are polarized. The positive lead goes in the hole on the board marked with a "+". **NOTE: The orientation of the positive (+) leads are not all the same.** Be careful! The negative or the positive lead may be marked.

Ok	Procedure
	Install a 10 uF electrolytic capacitor at C18.
	Double-check polarity and then solder/clip 2 leads.

Trimmer Installation

Ok	Procedure
	Install 10 kilohm trimmers at R18 and R21.
	Solder and clip 6 leads.

Header and Connector Installation

Headers

The male headers will be installed next. The plastic body of the part should rest flush with the top surface of the PC board. Note that the short end of the pins go into the PC board, the long ends stick up.

WARNING! Do not hold these parts with your fingers while soldering. The pins get very hot. Place one of the shunts on the header to insulate your finger from the pins, hold the header in place and tack solder one pin. Check for proper alignment. If alignment is off, you can reheat the pin to adjust. Once alignment is correct, solder the remaining pins and then reflow (reheat) the first pin soldered.

Ok	Procedure
	Install 2-pin headers at JP7 and TP1.
	Install shunts, and solder 2 pins.
	Install the 2 pin polarized Molex header at JP19. Position the header so that the locking pin faces the back of the board.
	Install shunts, and solder 2 pins.
	Install 3 pin headers at JP1, JP2, JP3, JP4, JP5, JP6, JP8, JP11, JP12, JP13, JP14, JP15, JP16, and JP17
	Install shunts, and solder 36 pins.
	Install 2x5 (10 pin) headers at SV1 and SV2. If your kit includes one 2x10 (20 pin) header, it is a “snap off” type and can be broken into two by gripping with pliers at the midpoint and breaking.
	Solder 10 pins
	Remove any shunts used during the soldering operation.

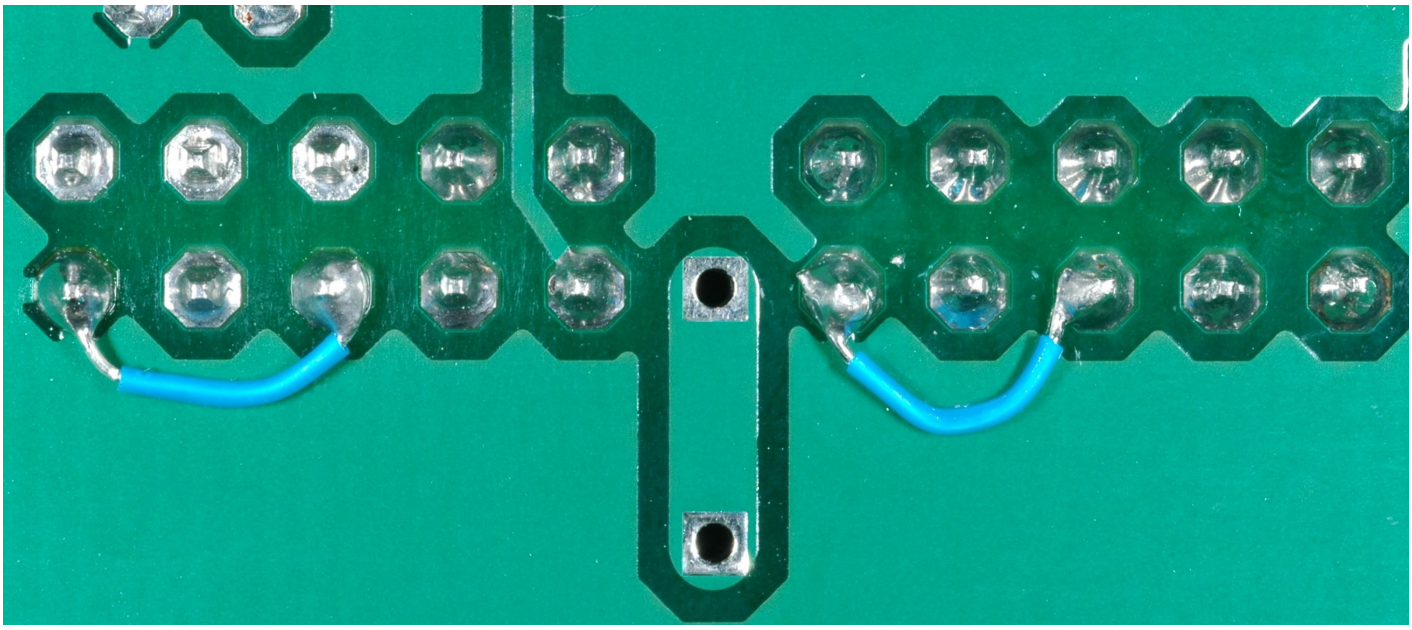
Connectors

	Install BNC connectors at at J1, J2, J3, J4, J5, J6, J7. J8
	Solder 32 pins.

Blue Wires

Due to a layout error, the 10 pin headers for RS-232 output do not match standard ribbon-cable DB-9 or DB-25 connectors. While the PPS signal is properly located on the DCD line (pin 1 of a DB-9), the ground signal is on the "Ring Indicator" line (pin 9 of a DB-9) instead of signal ground (pin 5 of a DB-9).

This can be corrected by adding a jumper wire from pin 9 of each header (if you count even pins on one row, odd pins on the other) to pin 5, as shown in the photo below. If your application is unhappy to find a ground on the RI line, you may need to clip pin 9 on the header.



In addition, the spacing between the two headers is a little tight and fitting a pair of ribbon cable connectors may be difficult. Filing the edges of the connectors will free up enough room. Sorry about that.

Initial Test -- 1

Preliminaries

Errors take two forms, the kind that damage components and the kind that don't. Neither is desirable, but the type that damages components will require you to find a replacement part. Before connecting the board for the first time, check the following:

Ok	Procedure
	Polarity of the electrolytic capacitor. The negative lead is usually identified with a white stripe and a big minus sign on it. The positive lead is identified on the PC board.
	Polarity of the seven tantalum capacitors. The positive lead is usually identified with a red line and plus signs.
	Polarity of diode D1. The band on the diode should align with the extra stripe on the PC board silkscreen.
	The orientation of the integrated circuits with pin 1 correctly oriented to the dot, notch or bevel outline on the PC board.

Be Alert! Observe anything unusual such as components heating up, smoke or smell. If anything unusual appears, immediately turn off the power. Find and correct all problems before continuing.

Ok	Procedure
	Place the ground lead of your meter on the anode (opposite the banded end) of D1. This is ground reference for all measurements.
	With the meter set to read ohms, check pins 1 and 3 of IC8. These may show a low resistance initially because of charging effects, but after a few seconds the resistance at pin 1 should be greater than 10kohms, and at pin 3 greater than 500 ohms. If either shows a very low resistance, check your work for short circuits.

Integrated Circuit Installation -- 1

Integrated circuits are polarity sensitive devices. The small notch in the body is on the end with pins 1 and 8. Make sure the notch on the component matches the one on the silkscreen!

Ok	Procedure
	Install a 7805 voltage regulator IC at IC8. The regulator can be mounted either flat on the board, or standing vertically, depending on the space available in your configuration. The heat sink tab should face the bottom or the back of the board.
	Solder and clip 3 leads.

Initial Test -- 2

Ok	Procedure
	Place the ground lead of your voltmeter on the anode (opposite the banded end) of D1. This is ground reference for all measurements.
	Apply 13.8V power to JP5.
	Measure the voltage on the 5V bus by connecting the other lead of the meter to the cathode of D1. This should be 5 volts, ±0.25V. If not, fix the problem before proceeding.
	If you have an ammeter, measure the current draw on the 12 volt input. It should be less than 25ma. If it is significantly more, there is likely a short circuit.
	Remove power from the circuit.

Integrated Circuit Installation -- 2

Integrated circuits are polarity sensitive devices. The small notch in the body is on the end with pins 1 and 8. Make sure the notch on the component matches the one on the silkscreen!

Do not mount the LT1016 ICs in sockets! Using sockets could lead to circuit instabilities.

Ok	Procedure
	Install 14 pin sockets at IC1, IC2, IC3, and IC4.
	Solder 56 pins.
	Install a 16 pin socket at IC6.
	Solder 16 pins.
	Install LT1016 ICs at IC5 and IC7. Make sure the notch in the chip lines up with the notch in the silkscreen outline. ***DO NOT USE SOCKETS FOR THESE CHIPS.***
	Solder 16 pins.
	Carefully insert 74AC04N ICs into the sockets at IC1, IC2, and IC4. Make sure the notch in the chip lines up with the notch in the socket.
	Carefully insert a 74AC14N IC into the socket at IC3. Make sure the notch in the chip lines up with the notch in the socket.
	Carefully insert a MAX232 chip into the socket at IC6. Make sure the notch in the chip lines up with the notch in the socket.

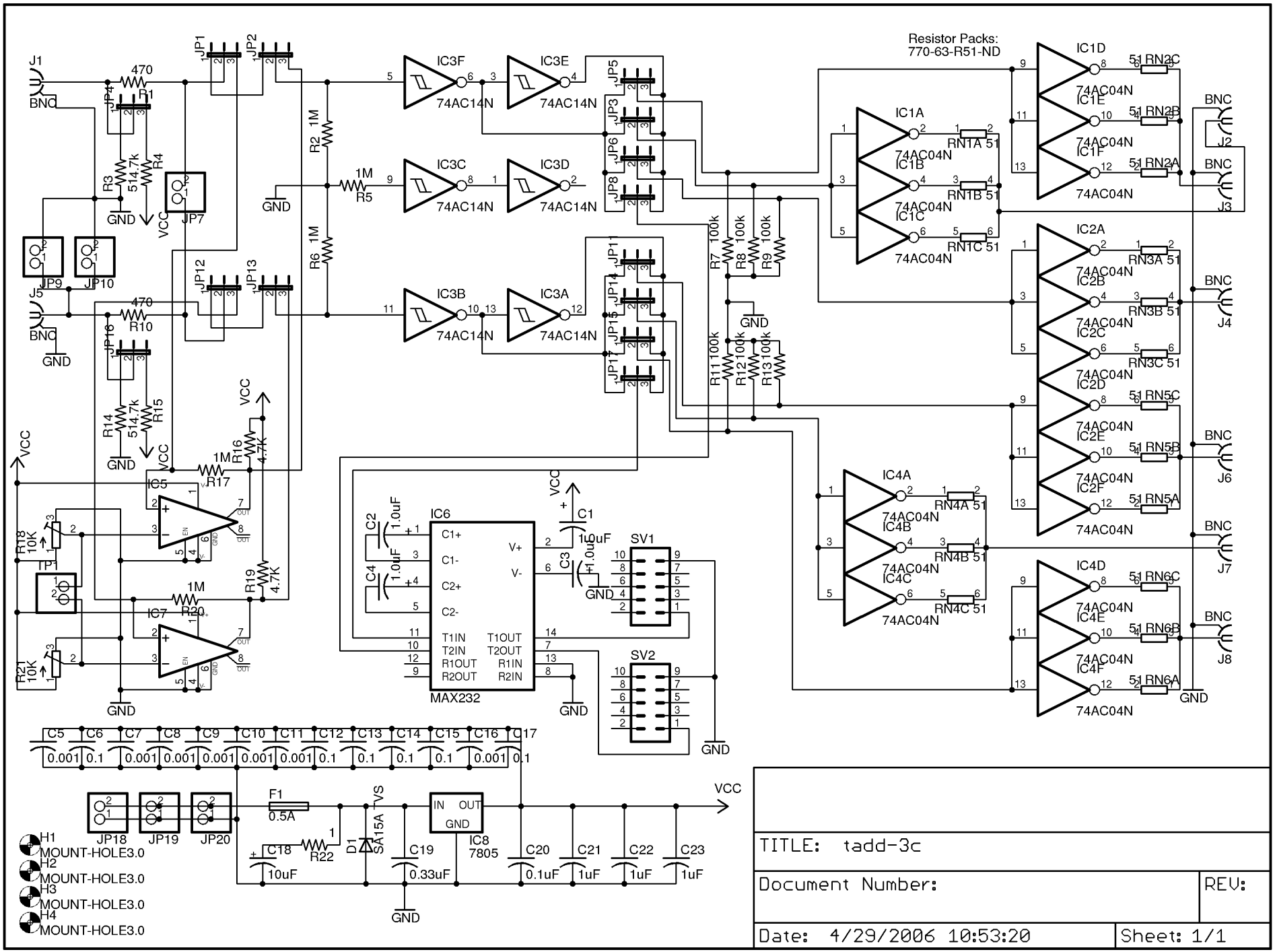
Initial Test -- 3

Ok	Procedure
	If you have an ammeter, connect it in series with the 12 volt power lead and make this test.
	Apply 13.8V power to JP5, preferably using a current-limited power supply set to limit at about 150ma.
	Measure the current draw. It should be about 70ma. If it is over 150ma, there is likely a short in the DC bus, or one or more high impedance IC inputs have been left floating.
	Remove power from the circuit.

Board Check

This completes assembly of the TADD-3. At this point, components, their location, and proper orientation should be double-checked. Soldering must be carefully inspected, preferably with a lit magnifier. If there are any suspicious solder connections, reflow the solder and check the result. Do this until you are satisfied that the board is OK.

Ok	Procedure
	Board checked and OK.


Resistor Packs:
770-63-R51-ND
74AC14N
74AC04N
MAX232
MOUNT-HOLE3.0
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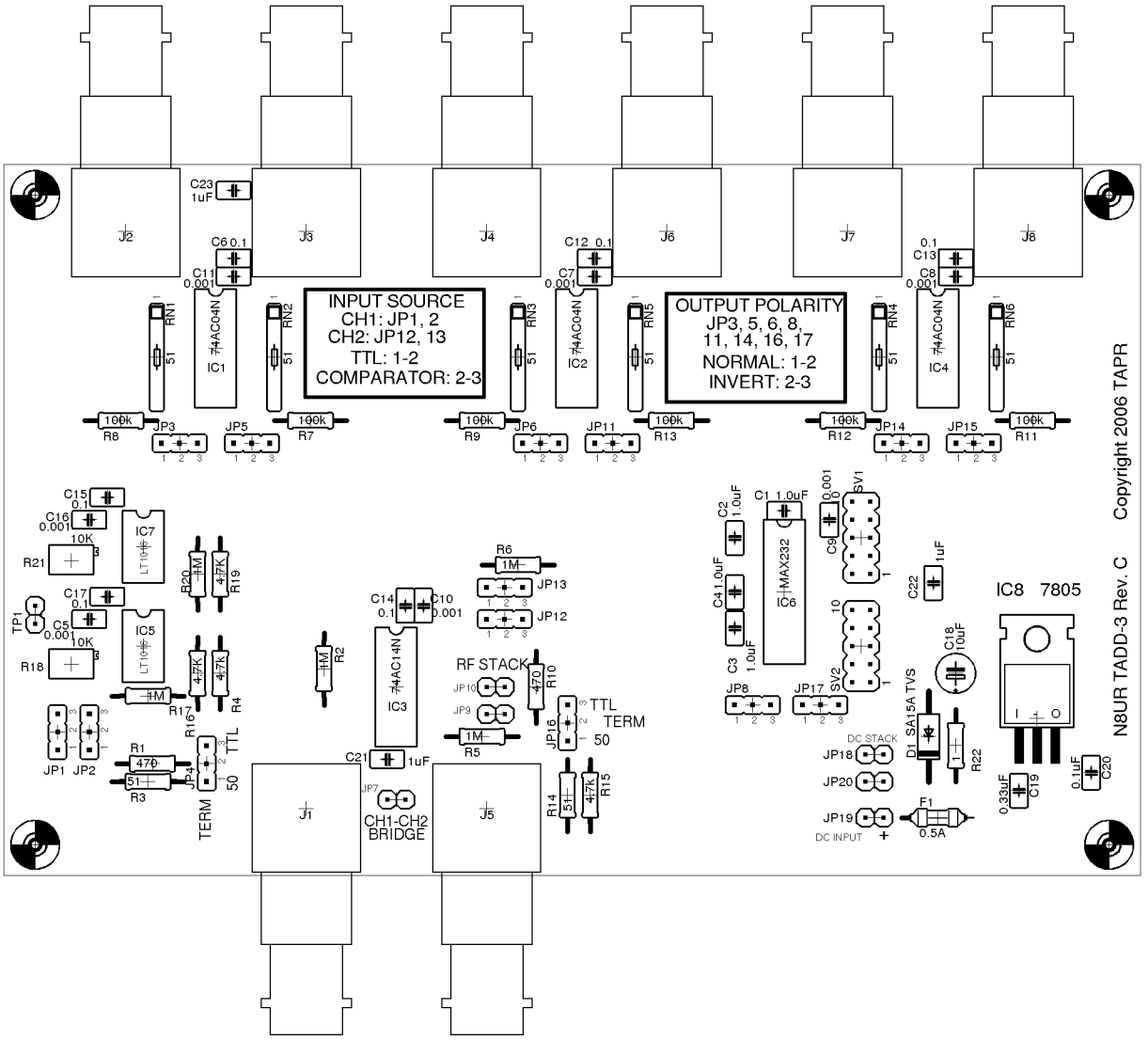
INPUT SOURCE
CH1: JP1, 2
CH2: JP12, 13
TTL: 1-2
COMPARATOR: 2-3
OUTPUT POLARITY
JP3, 5, 6, 8,
11, 14, 16, 17
NORMAL: 1-2
INVERT: 2-3
CH1-CH2
BRIDGE
RF STACK
TTL
TERM
50
DC INPUT
IC8 7805
MAX232
74AC04N
74AC14N
SA15A TVS
0.5A
N8UR TADD-3 Rev. C
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