

# TADD-2 Assembly and Operation Manual

RF to PPS Divider

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## PRELIMINARY

### Introduction

The TADD-2 is a frequency divider that accepts a 5 or 10 MHz input signal and generates pulse-per-second (“PPS”) and other low rate digital outputs. Its primary purpose is to provide a low-jitter PPS output from a frequency standard; this PPS signal can be used for various timing measurements.

The TADD-2 is designed to be very versatile and offer flexibility in use. The six outputs are low impedance sources capable of driving coax lines with at least 3 volts into a 50 ohm load. The input and outputs use BNC connectors. Each output can be individually set to pulse rates of 10 KPPS, 1 KPPS, 100 PPS, 10 PPS or 1 PPS, all with 20% duty cycle, or to a 10% duty cycle PPS rate. The polarity of each output can also be set to normal (transition low-to-high) or inverted (transition high-to-low). There is a seventh true TTL output available via pads on the board. Each output can be set to invert the input, or maintain the same polarity.

The divider can be synchronized to an external signal (for example, to sync it to the PPS signal from a GPS receiver). Three LEDs indicate sync status as well as PPS activity.

The TADD-2 includes fused and reverse-polarity protected 5 and 10 volt regulators. The supply voltage can range from 12 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

[ Still to come. ]

The pulse rate of each output is set by installing one shorting jumper on the associated header JP8 – JP13 (channel 1 is set by JP8, channel 2 by JP9, etc.). All outputs are 20% duty cycle, except the “PPS” signal (as distinguished from the “1 Hz” signal) which is a 10% duty cycle. Headers JP15 – JP20 set the output polarity -- “normal” is normally low output, going high on the leading edge of the pulse. “Inverted” is the opposite.

John Miles, KE5FX, has noted that some crosstalk appears on an output channel if the other channel sharing the same 74AC04 output driver chip is set for a higher rate. For example, if channel 1 is set for 1 PPS and channel 2 for 1K PPS, there will be signs of the 1K pulse train on the PPS output. While this crosstalk is at a fairly low level, it can cause triggering problems with devices that have sensitive inputs. To avoid this, try to set each pair of channels (channels 1 and 2, 3 and 4, and 5 and 6) to the same rate.

The synchronization circuit works as follows. Momentarily shorting the two pins of the ARM connector (JP1) stops the PIC counter. Both the red ARM and green SYNC LEDs will illuminate. The rising edge of a

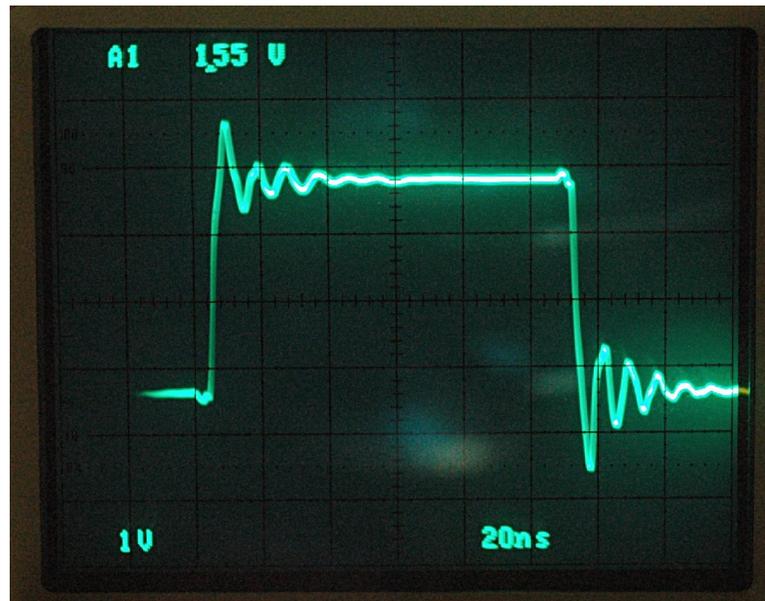
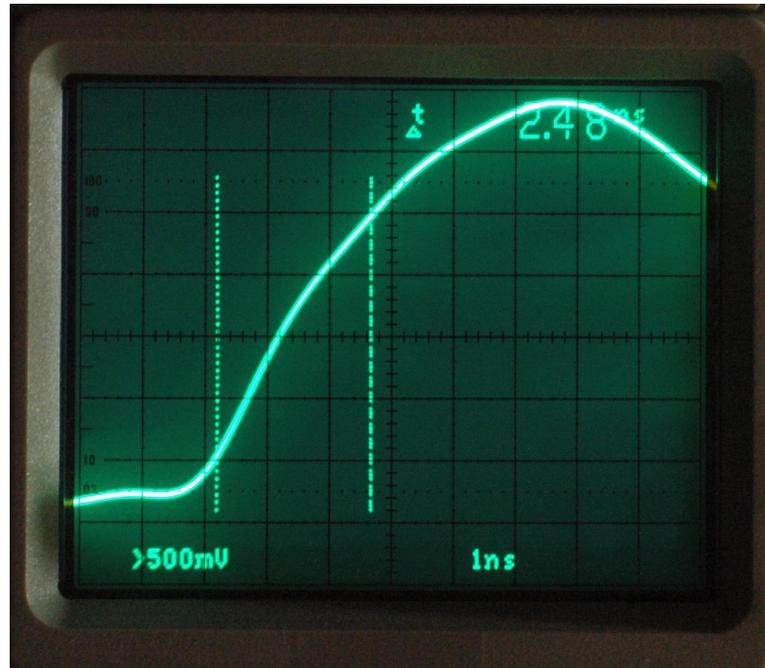
TTL-level signal on SYNC input J1 will start the counter. The red LED will go out while the green LED stays illuminated. The pulse train on the output will now be synchronized to the SYNC pulse, within one or two clock cycles (*i.e.*, 100 or 200 nanoseconds at 10 MHz). The SYNC pulse polarity can be set via JP4. Once the counter is synchronized, the SYNC input may be removed.

# 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-2 kit includes the printed circuit board, one or two tubes containing ICs and sockets, a bag with eight BNC connectors, and several manila envelopes containing small components (the exact arrangement may vary depending on the mood of the guy stuffing the envelopes; please check all of them before assuming parts are missing!). 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-2" 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-2 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	NAME	VALUE	PART ID
	4	Capacitor, tantalum 12V	1.0uF	C1, C3, C17, C28
	8	Capacitor, mono	0.001uF	C2, C12, C16, C18, C19, C20, C21, C22
	2	Capacitor, tantalum 25V	0.33uF	C4, C8
	9	Capacitor, mono	0.1uF	C5, C10, C14, C15, C23, C24, C25, C26, C27
	4	Capacitor, mono	0.01uF	C6, C7, C9, C11
	1	Capacitor, electrolytic, 25V	10uF	C13
	1	Diode	SA15A TVS	D1
	1	PICOFUSE	0.5A	F1
	1	VOLTAGE REGULATOR	7805	IC1
	1	Schmitt Trigger	74AC14N	IC2
	1	VOLTAGE REGULATOR	78L10Z	IC3
	1	PIC	PIC16F8DIL	IC4
	5	Hex Inverter	74AC04N	IC5, IC6, IC7, IC8, IC9
	7	Socket, 14 pin DIL		
	8	BNC RA with washer and nut	AMP227161	J1, J2, J3, J4, J5, J6, J7, J8
	2	Polarized Power Connector	Molex	JP1, JP2
	2	Polarized Shell	Molex	
	4	Pin	Molex	
	7	3 Pin Header		JP4, JP15, JP16, JP17, JP18, JP19, JP20
	2	2 Pin Header		JP7, JP14
	6	12 pin (6x2) Header		JP8, JP9, JP10, JP11, JP12, JP13
	15	2 Pin Shorting Jumper		
	1	LED, Red		LED2
	2	LED, Green		LED1, LED3
	2	PNP Transistor	2N3906	Q1, Q2
	1	RESISTOR, American symbol	10K	R1
	1	RESISTOR, American symbol	120	R2
	1	RESISTOR, American symbol	51	R3
	7	RESISTOR, American symbol	100k	R4, R20, R21, R22, R23, R24, R25
	2	RESISTOR, American symbol	3.3k	R5, R11
	1	RESISTOR, American symbol	220	R6
	2	RESISTOR, American symbol	6.8k	R7, R10
	1	RESISTOR, American symbol	270	R8
	1	RESISTOR, American symbol	1	R9
	6	RESISTOR, American symbol	680K	R12, R13, R14, R15, R16, R17
	2	RESISTOR, American symbol	150	R18, R19
	6	SIL RESISTOR	47	RN1, RN2, RN3, RN4, RN5, RN6
	1	T1-1 Transformer	MCL	T1

# Assembly Notes

## Diodes

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.

## Capacitors

Electrolytic and tantalum 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.

## Headers and Molex Connectors

The plastic body of the male headers and Molex connectors 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 complete, resolder the pins to ensure a good connection.

## Connectors and Extra Holes

The two Molex polarized connectors are installed in JP1 (ARM) and JP2 (DC IN) so that the two pins face the edge of the board, with the plastic latch piece facing into the board.

Header JP5 is not normally installed on the board. It provides an extra PPS signal (positive going, 10% duty cycle) using a spare 74AC14 inverter gate. This signal may be used to drive TTL or CMOS loads.

Headers JP3 and JP6 are not normally installed on the board. They are in parallel with the DC power input and can be used to daisy-chain boards requiring the same voltage.

## LED Brightness

The 220 ohm resistor driving LED 1, and the 150 ohm resistors driving LEDs 2 and 3, may be adjusted to change the LED brightness if desired. The resistors on LEDs 2 and 3 are smaller in value than expected because of the limited current that the PIC chip can source.

## Transformer Polarity

The dot on transformer T1 is on the same end as pin 1, and the transformer should be mounted so the dot is aligned with the notch in the silkscreen. However, this transformer is actually symmetrical, so no harm is done if it is mounted backwards.

# 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 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 IC1. 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 IC1. 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.
	Install a 78L10 voltage regulator at IC3.

## 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 JP2.
	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, $\pm 0.25V$ . If not, fix the problem before proceeding.
	Measure the voltage on the 10V bus by touching the other lead of the meter to the left lead of R2 (when looking at the board from the RF Input connector side). This should be 10 volts, $\pm 0.25V$ . 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 15 ma. If it is significantly more, there is likely a short circuit.
	Remove power from the circuit.

## Integrated Circuit Installation -- 2

Install IC 2 and IC 4 through IC 9. Integrated circuits are polarity sensitive devices. The small notch in the body is on the end with pin 1. Make sure the notch on the component matches the one on the silkscreen!

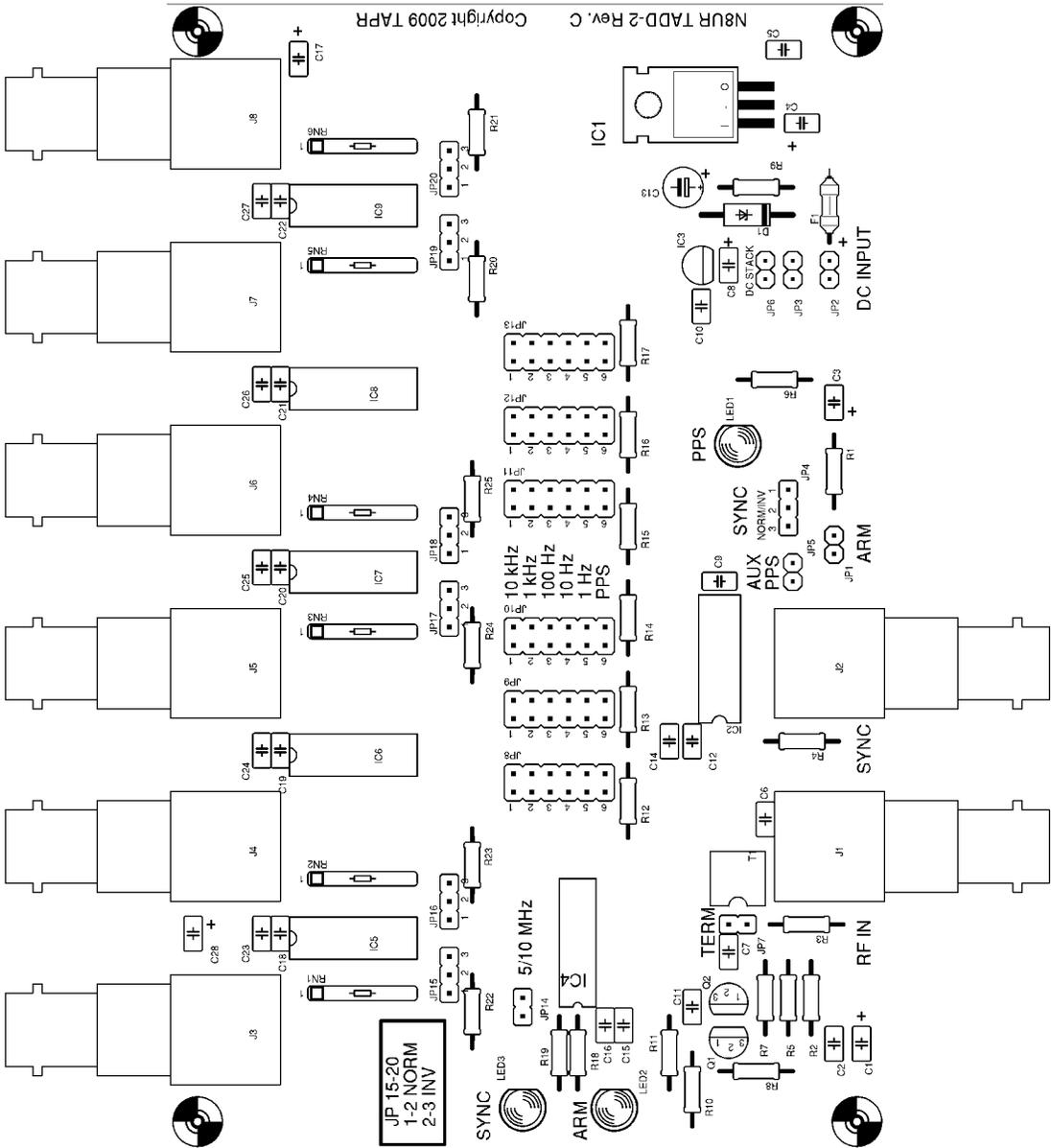
## Initial Test -- 3

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 JP2, preferably using a current-limited power supply set to limit at about 150ma.
	Measure the current draw. It should be about 35ma. If it is over 75ma, 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-2. 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.

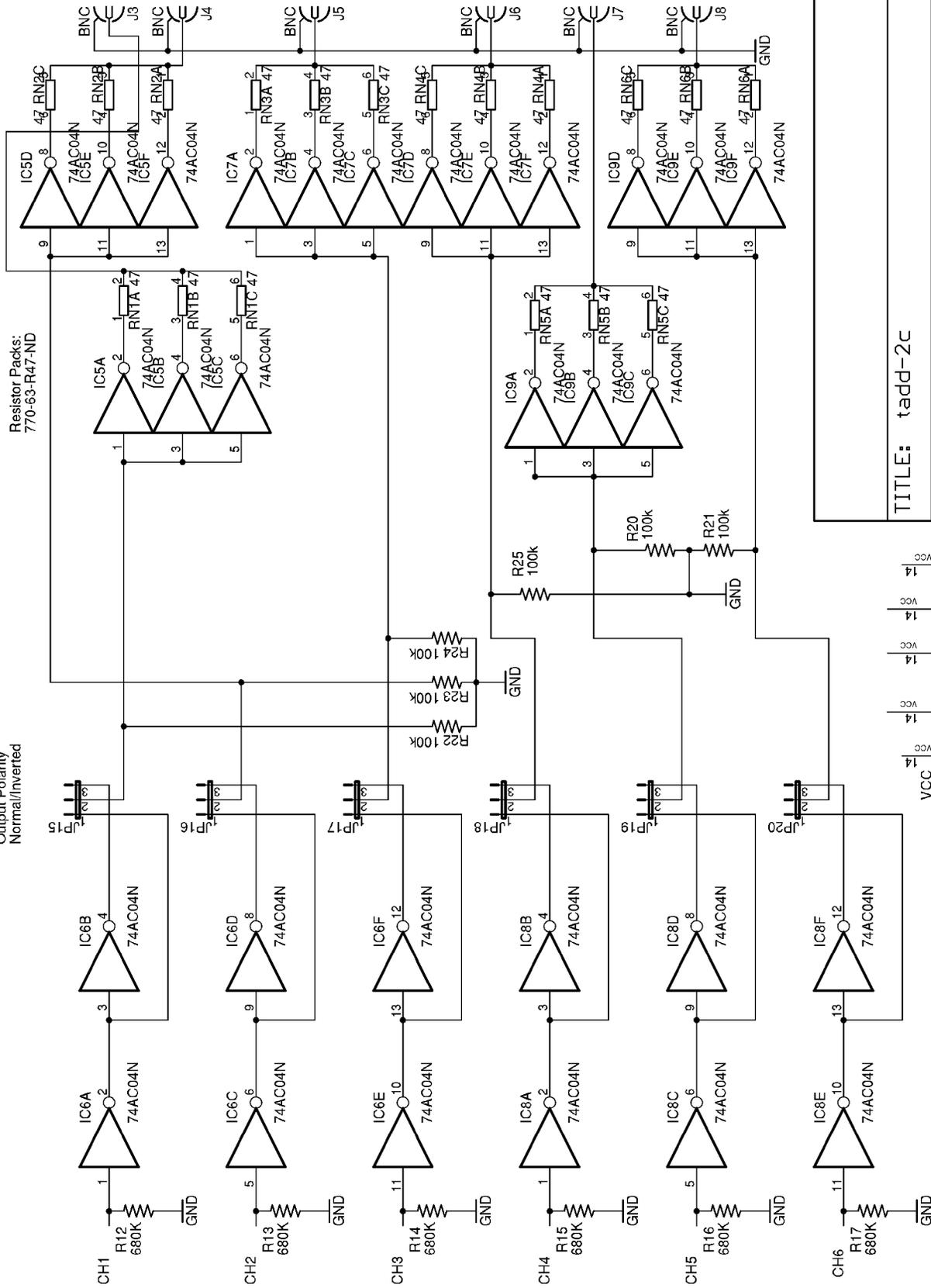
Ok	Procedure
	Board checked and OK.



JP 15-20  
 1-2 NORM  
 2-3 INV



Output Polarity  
Normal/Inverted



Resistor Packs:  
770-63-R47-ND

VCC	14	7	14	7	14	7
IC6P	IC5P	IC7P	IC9P	IC8P	GND	GND
14	7	14	7	14	7	14

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