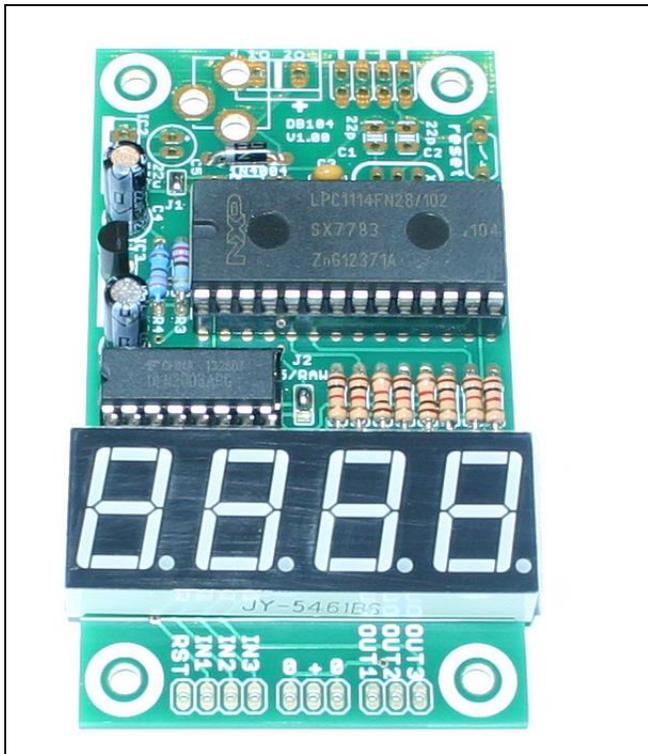


## Dwarf Boards

### DB104 : LPC1114 LED seven-segment counter

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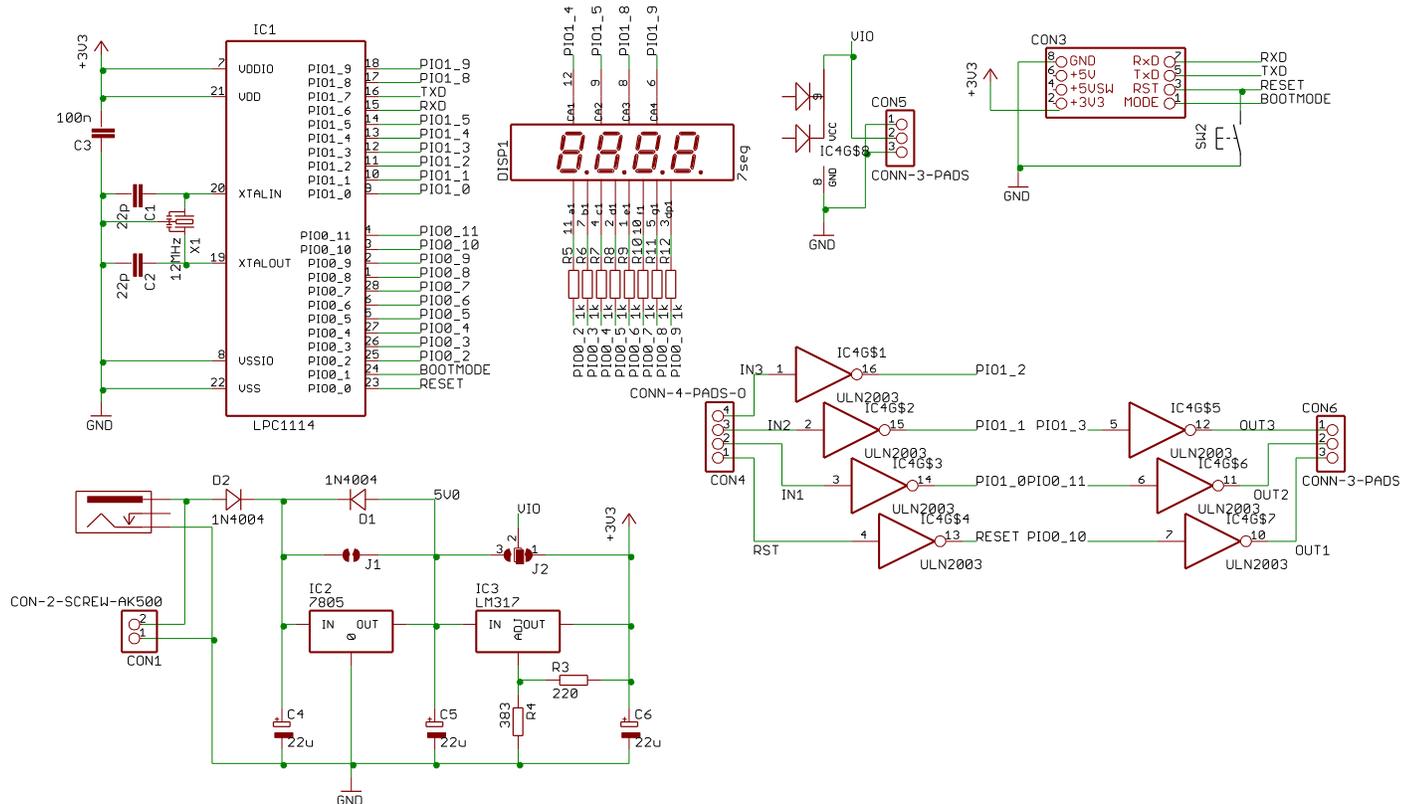


DB104 – basic counter configuration

## Introduction

This document describes the Dwarf Board DB104. In the basic counter configuration this board contains an LPC1114 Cortex M0 microcontroller, a four-digit seven-segment LED display, and an ULN2003A buffer chip. An LM317 voltage regulator provides the 3.3V for the LPC1114. The LPC1114 is pre-programmed with software that implements a simple cascadable up/down counter.

Circuit



The main components are

- the LPC1114 microcontroller (top left)
- A 4 digit seven-segment LED display (top middle)
- An LM317 regulator configured to provide 3.3 Volt (bottom left)
- An ULN2003A buffer chip that buffers the 4 inputs and 3 outputs (middle right)

A number of optional components are not fitted for the basic counter board:

- A crystal or resonator for the microcontroller
- An 7805 or similar regulator that provides regulated power to the interface connector (bottom left)
- Center-barrel or screw type connectors for input power (bottom left)
- An in-circuit download connector and a reset switch (top right)

In the basic counter configurator solder jumper J1 is closed (because IC2 is not fitted) and for J2 the 2-3 connection is made, so the unregulated input voltage is available on CON5.

The LPC1114 microcontroller can use a crystal or resonator, but it can also run from its internal 12 MHz oscillator, which is accurate to about 1%. The LED display is a high-brightness type, hence the microcontroller can drive the LEDs without a driver chip. The peak segment current is ~ 1mA. The ULN2003A input/output buffer has 7 inverting open-collector buffers. These buffers serve to isolate the microcontroller from whatever is connected to the counter print, and allow it to drive for instance a relay coil directly (the ULN2003A has built-in freewheel diodes).

## Interface

The counter print has a row of 10 solder pads for interfacing and a place for either a center-barrel or screw-type connector for power.

| Picture | PCB name | Function  | Explanation   |
|---------|----------|-----------|---|
|         | OUT3     | -         | Not used  |
|         | OUT2     | Zero      | This line is pulled low while the counter is at 0000.   |
|         | OUT1     | Carry     | This line is pulled low when the counter overflows or underflows. With an external pull-up resistor it can be connected to the Clock input of a next counter. |
|         | 0        | Ground    | Interface ground  |
|         | +        | Power     | Power   |
|         | 0        | Ground    | Interface ground  |
|         | IN3      | Direction | A low level on this pin causes the counter to step  |
|         | IN2      | Auto      | A high level on this pin and also on the clock pin causes the counter to step at ~ 10 Hz.   |
|         | IN1      | Clock     | A low-to-high transition causes the counter to take one step. This is sampled at ~ 20 Hz to suppress switch bouncing.   |
|         | RST      | Reset     | A high level resets the circuit. The display is blanked while the reset is active.  |

When unconnected the inputs are low. To make an input high you can connect it to the Power (marked as +). In the basic configuration (without IC2 fitted) this power is the same as supplied to the board at the other end (center-barrel connector, screw connector, or soldered directly to the board).

The outputs are open-collector, capable of sinking 200mA without any problem (consult the ULN2003A datasheet for details). Each output has a flyback diode to Power, so a small relay coil can be connected directly (for instance between power and Zero).

The Carry output can (with a suitable pull-up, for instance 1k $\Omega$ ) be connected to the Clock input of a next counter board make an 8 digit counter.

## Change notes

The latest version of this document can be downloaded from <http://www.voti.nl/DB100>

| <b>Version</b> | <b>Date</b> | <b>Notes</b>  |
|----------------|-------------|---------------|
| 1.0            | 2013-04-05  | first version |