Computing stuff tied to the physical world

Fixing the Arduino's PWM #2

In AVR, Software on **Nov 9, 2011** at **00:01**

Yesterday's post identified a problem in the way different PWM pulses are generated in the ATmega.

It's all a matter of configuration, since evidently the timers used to generate the PWM signals all run off the same clock signal, and can therefore be made to cycle at *exactly* the same rate (they don't have to roll over at the same time for our purposes, but they *do* have to count equally fast).

The problem is caused by the fact than PWM pins D.5 and D.6 are based on timer 0, which is also used as millisecond timer, whereas PWM pin D.9 is based on timer 1. It's not a good idea to mess with timer 0, because that would affect the delay() and millis() code and affect all parts of a sketch which are timing-dependent.

Timer 0 is set in "Fast PWM" mode, which is not perfect. So the Wiring / Arduino team decided to use "Phase Correct PWM" mode for timers 1 and 2.

In *Fast PWM* mode, the timer just counts from 0 to 255, and the PWM output turns high when the counter is in a specific range. So far so good.

In *Phase Correct PWM* mode, the timer counts from 0 to 255 and then back to 0. Again, the PWM output turns high when the counter is in a specific range.

The phase correct mode counts up and down, and takes twice as long, so that explains why the green LED output runs at half the speed of the others.

Except that… it's not exactly twice!

Timer 0 wraps every 256 counts, and that should be kept as is to keep the millisecond code happy.

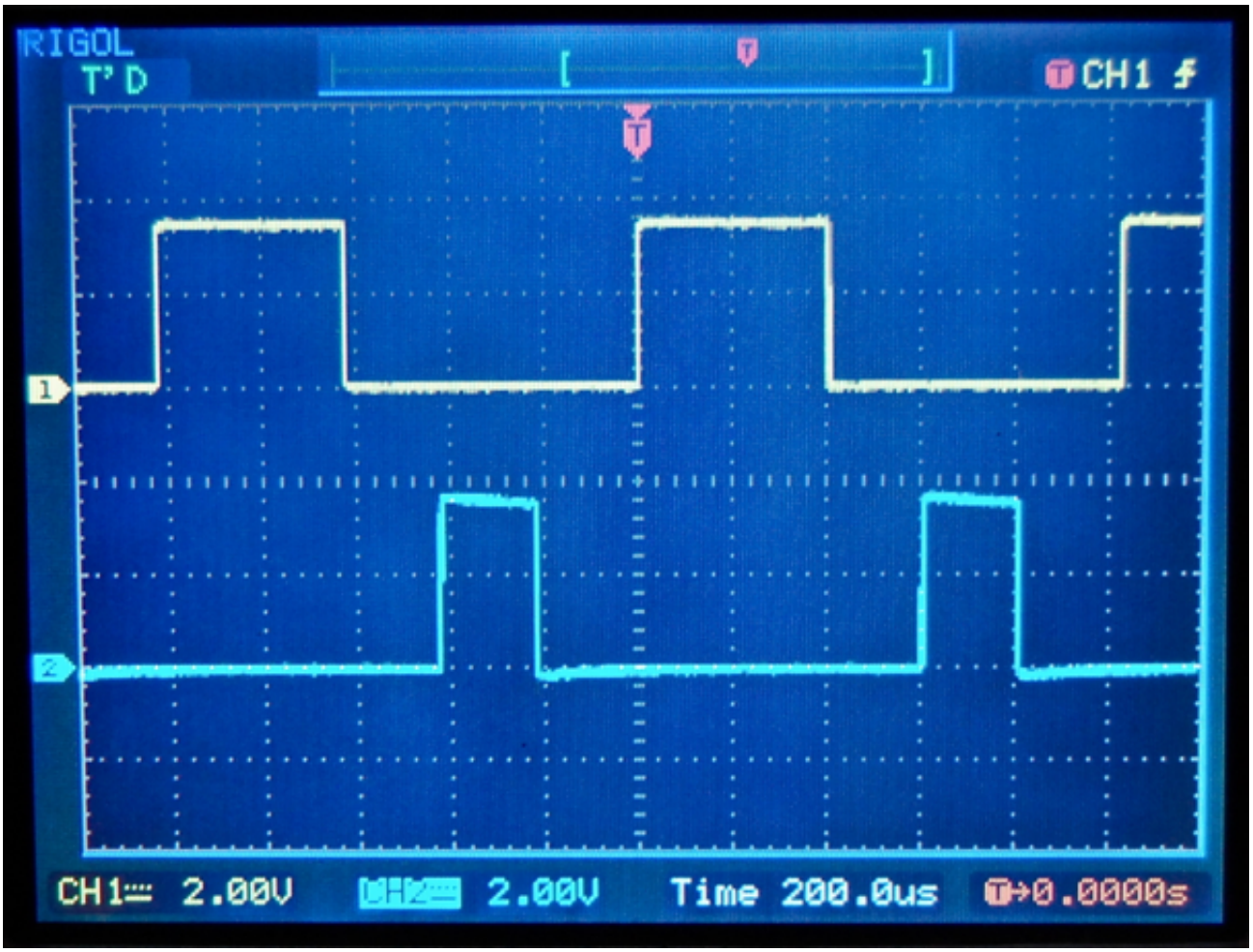
But timers 1 and 2 wrap every 0 -> 255 -> 0 = 511 counts (I think – or is it 510?). Hence the out-of-sync effect which is causing so much trouble for the LED Node.

See also Ken Shirriff informative page titled Secrets of Arduino PWM, for the ins and outs of PWM.

The solution turns out to be ridiculously simple:

```
bitSet(TCCR1B, WGM12);
```

Just adding that single-bit change to setup() will force timer 1 into Fast PWM mode as well. The result:



This picture was taken with the scope running. The signals are in lock-step and rock solid. More importantly, the result is a perfectly smooth LED light – *yippie!*

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  - October 2013
  - September 2013

- July 2013
- June 2013
- May 2013
- April 2013
- March 2013
- February 2013
- January 2013
- December 2012
- November 2012
- October 2012
- September 2012
- July 2012
- June 2012
- May 2012
- April 2012
- March 2012
- February 2012
- January 2012
- December 2011
- November 2011
- October 2011
- September 2011
- June 2011
- May 2011
- March 2011
- February 2011
- January 2011
- December 2010
- November 2010
- October 2010
- September 2010
- August 2010
- July 2010
- June 2010
- May 2010
- April 2010
- March 2010
- February 2010
- January 2010
- December 2009
- November 2009
- October 2009
- September 2009
- August 2009
- July 2009

- June 2009
- May 2009
- April 2009
- March 2009
- February 2009
- January 2009
- December 2008
- November 2008
- October 2008
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- Linux
- Musings
- News
- Software

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