BMW K100, 7 segment gear indicator replacement.

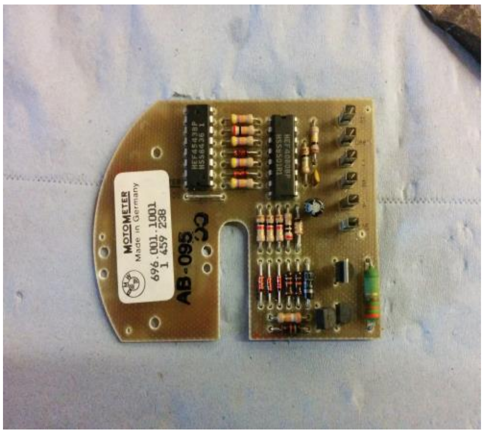
The original LCD gear display on K bikes is prone to bleeding out and becoming unreadable. Happened to mine and while it's not really a problem, while I was inside the speedo trying to sort another problem, I thought I'd try to source a replacement.

I tried to find a source for a replacement LCD that could be made to fit but found nothing. Options are limited to trying to find a good second hand one or making something else fit. Finding a questionably reliable second hand one was looking expensive so I've come up with a way to make a cheap LED one fit.

To do the same you will need:
-To be able to confidently dismantle the speedo unit. It's not too tricky a bit of common sense and there was a guide online I looked through somewhere too. There are no special tools required although I do have one for removing the needles which I'll photograph later but it's not really necessary.
-Access to a fairly fine soldering iron, solder and the skill to use one. Nothing too scary.
-A new LED 7 segment display unit. I found these fit okish but any 0.39inch ones should do the trick. You could probably order a dozen for the same price from the Far East but I wanted them ASAP. I think the black/white ones might look better.
http://www.ebay.co.uk/itm/112039276570?_trksid=p2057872.m2749.l2649&var=410975301998&ssPageName=STRK%3AMEBIDX%3AIT
-7 x resistors. These are needed to protect the LED segments. The values depend on the LED unit you buy. For the one above, I used 390ohm resistors. I expect that value would be fine for most units that would fit in the hole.
-A small bit of prototyping board.
-Some very fine heat shrink
-A short length of insulated, fine cable.
-A Dremel is handy and the ability drill tiny holes a real bonus.

Once you've pulled the guts of the speedo out of the case, get the gear indicator board out. It's below the rev counter so you'll need to carefully remove the needle. Mine was very tight but I have a nice tool for removing them:

The board slides off its connectors and it can be take off. This is what I call the top/front of the board:



(Despite it being the underside when in use)

The board takes Binary Coded Decimal (BCD) signals from presumably the gearbox, organises the neutral light/start to come on (when in neutral) and generates an output to drive the LCD screen. It also creates a flavour of electricity the LCD screen likes.

We need to retain the neutral light/start functionality so we don't want to ditch that bit of the board. However, we can't just solder in the new LED unit in place of the LCD one as they operate differently. Took me a while to figure out but LCDs need a square wave to work their magic, while LEDs are just little diodes that like nice, simple DC voltage.

So we need to alter the output of the board (to the display) from square wave to DC. Which is fine because it turns out that the chip that translates BCD into 7 segment display speak is happy to do it with either DC or the square wave. We just need to alter one pin on the chip and it will fire out DC for the LEDs.

The translation chip is the one nearest to the LCD display and it (mine) is labelled HEF4543BP. It's worth going and downloading this datasheet as it explains how it works (if you're interested) **http://www.datasheetspdf.com/PDF/HEF4543B/1089666/1**

This is the most useful bit:

active HIGH phase input (PH) and seven buffered segment outputs (O_a to O_g).

For liquid crystal displays a square-wave is applied to PH and the electrical common back-plane of the display. The outputs of the device are directly connected to the segments of the liquid crystal.

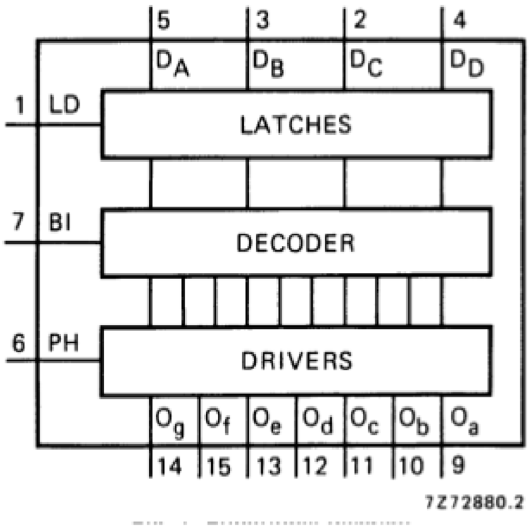


Fig.1 Functional diagram.

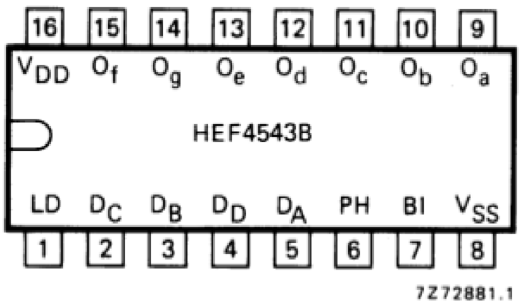


Fig.2 Pinning diagram.

HEF4543BP(N):	16-lead DIL; plastic (SOT38-1)
HEF4543BD(F):	16-lead DIL; ceramic (cerdip) (SOT74)
HEF4543BT(D):	16-lead SO; plastic (SOT109-1)

( ): Package Designator North America

PINNING

D_A to D_D	address (data) inputs
PH	phase input (active HIGH)
BI	blanking input (active HIGH)
LD	latch disable input (active HIGH)
O_a to O_g	segment outputs

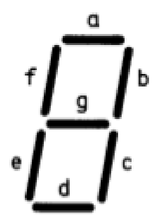
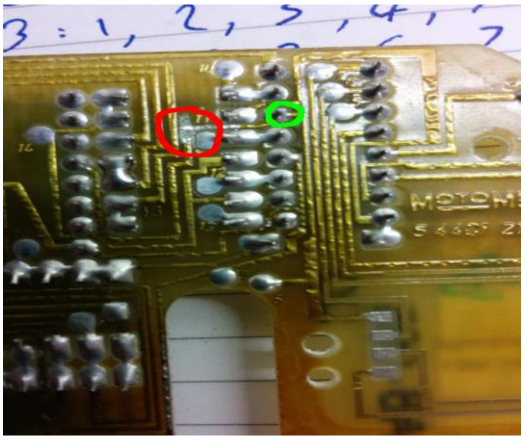


Fig.3 Segment designation.

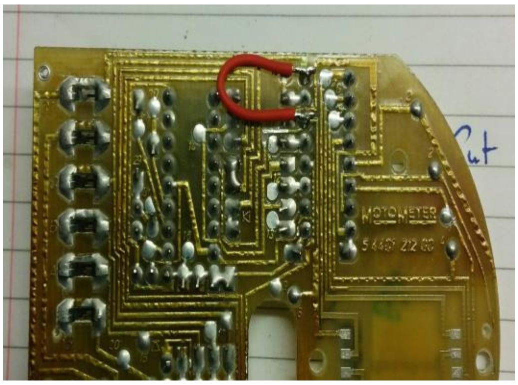
Take note of the pin locations and the orientation of the chip. The pinning diagram ^^ is mapped from the top of the board so when underneath, it'll need to be flipped over.

In order to make it translate into LED, you need to cut its feed of square wave and feed it DC.

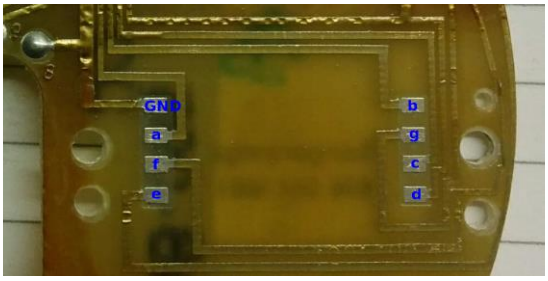
The pin we're interested in here is pin 6. Looking at the back of the board in the image below, it's the one circled in green.
You might as well remove the old LCD bit now if you haven't already. Keep the Perspex bit.
Go ahead and scrape off the track that feeds pin 6. I cut it at the corner, there is an "11" marked next to it. Scrape off enough that you're sure it is disconnected but try not to smoosh anything else. Circled in Red.



This was the square wave feed. Now go ahead and jumper either to "ground" or the +ve pin. This is either pin 8 or pin 16 respectively. Choose pin 8 if you want to use a common cathode LED, choose pin 16 for common anode. Both are easy enough to get so I chose the closest. Pin 8.



With that done, you should be getting +DCV out of the output pins when you change gear now. It's worth loosely plugging all the gubbins back into the bike at this point to make sure the circuit works and the gearbox output and everything in between. Study the .pdf and sketch down which pins relate to which segments, note that g and f are confusingly out of alphabetical order. Click through the gears and make sure you have DCV out at the appropriate pins for each of the gears.



For example for first gear you'd expect +ve on pins b and c. For third gear, on pins a,b,c,d and g. Make a note of the voltages you see. Mine were 10-11v.
As tempting as it is to wire in the LED unit right away, we can't unfortunately. These LEDs at these voltages need current limiting resistors. Have a read of this webpage for an explanation and the formula used to calculate your resistor values:
http://www.electronics-tutorials.ws/blog/7-segment-display-tutorial.html

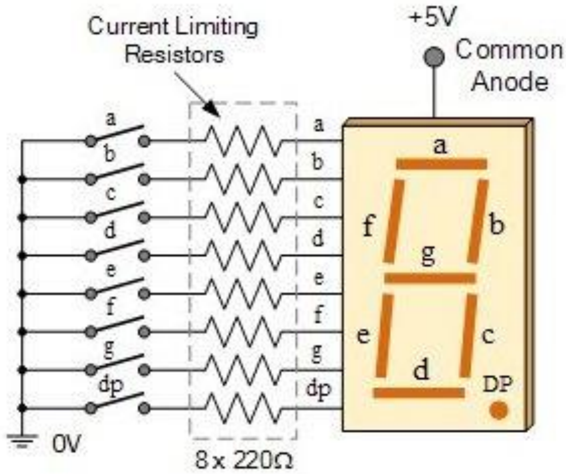
It's useful to read the whole thing and isn't too long but the most important bit is here:

The forward voltage drop across a red LED segment is very low at about 2-to-2.2 volts, (blue and white LEDs can be as high as 3.6 volts) so to illuminate correctly, the LED segments should be connected to a voltage source in excess of this forward voltage value with a series resistance used to limit the forward current to a desirable value.

Typically for a standard red coloured 7-segment display, each LED segment can draw about 15 mA to illuminated correctly, so on a 5 volt digital logic circuit, the value of the current limiting resistor would be about 200Ω (5v – 2v)/15mA, or 220Ω to the nearest higher preferred value.

So to understand how the segments of the display are connected to a 220Ω current limiting resistor consider the circuit below.

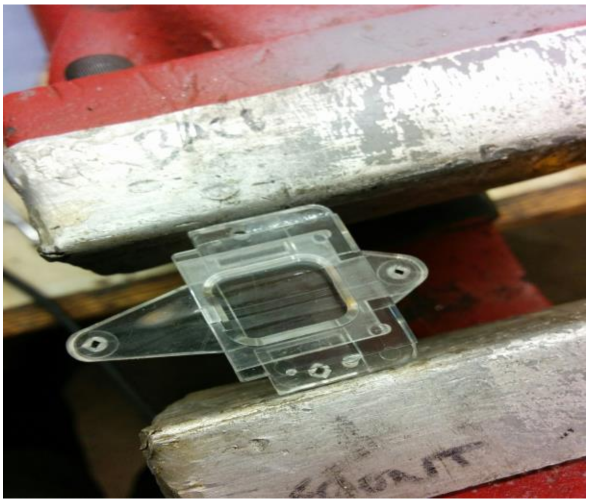
Driving a 7-segment Display



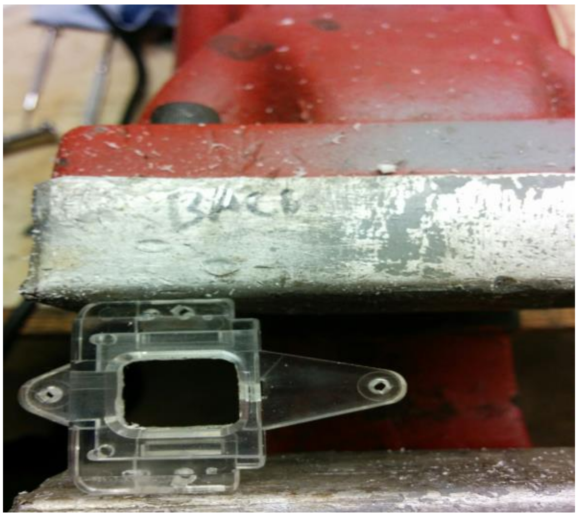
I worked out that I'd need about 375Ohms per segment. I went with 390Ohm resistors as I didn't want the display to be too bright at night.

Now it’s just a case of putting it all together.

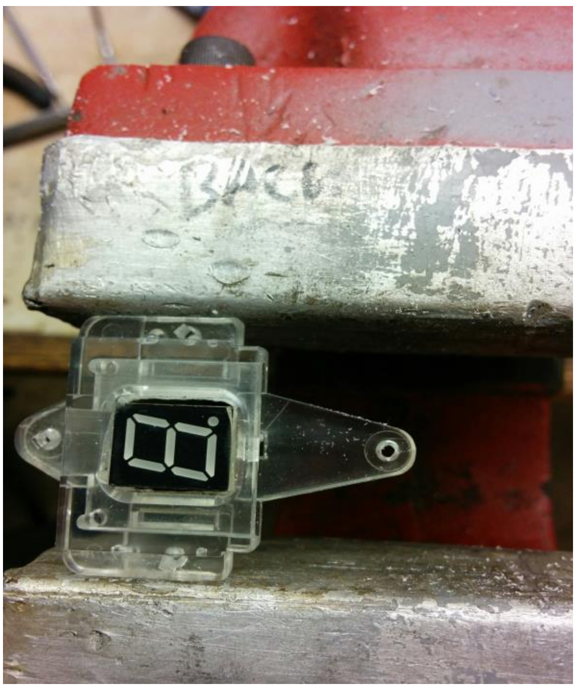
To get the fat LED to sit in the Perspex holder, you need to cut out the back of it. I sued a Dremel with a burr and managed not to gouge anything too drastically. A milling machine would be ideal, or you could just skip all this and blob it in place with hot glue. I think it would be perfectly adequate.



Before



Cut out



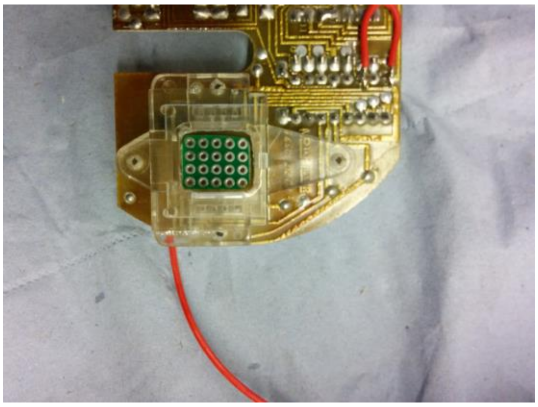
With LED installed.

I drilled out the pads originally used for the LCD connections and used them as take offs for the resistors.

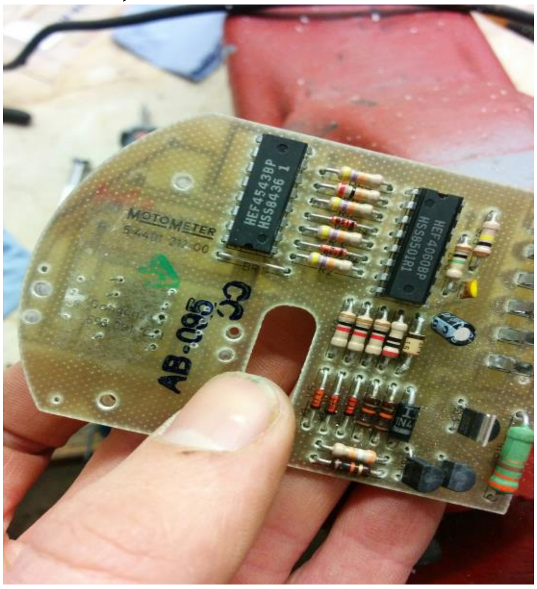
Doing this is ideal as it takes the resistors around to the front/top of the board where there is more space. You will need a 1mm drill bit or less (0.75mm is ideal) and a fast and accurate pillar drill though.

If that’s not going to work for you, you can just attach fine insulated cables either directly to the chip pins, those pads or the solder spots on the tracks.

Then I used a bit of prototype board as a guide to drill out the 10 holes for the legs of the indicator LED, the Perspex holder is there to get the position right:

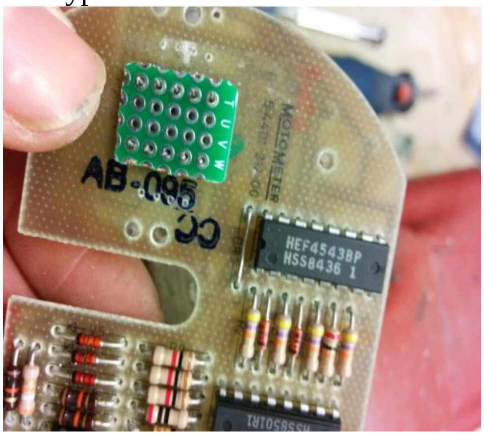


With that done, the front of the board looks like this:



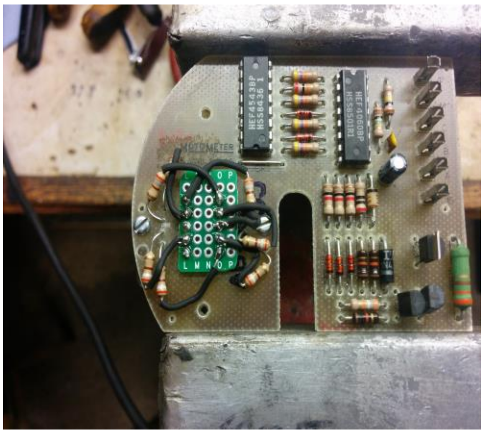
I’m holding the LED in place, you can see its legs poking through.

Now, that bit of prototype board can be used to secure the LED in place:



Solder in the resistors and you can begin connecting up the resistors to the legs of the LED.

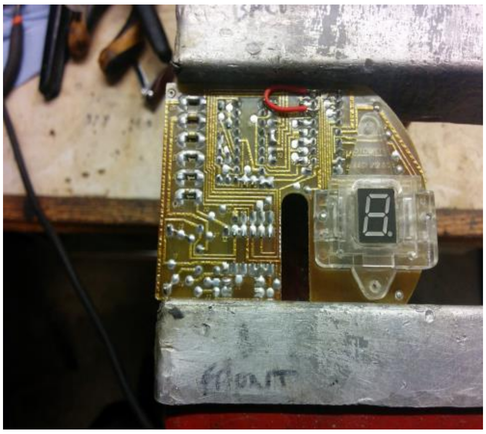
I’m not going to go through what to connect to where here, you can try to follow the layout I have done in the pic below but I wouldn’t recommend it. I had to alter one pin as I got it the wrong way round, turns out the diagram I was using for my LED pinout was not for the right model. So make your own mind up depending on the LED unit you buy and test it and test it again before you close up the case. It's worth ordering two of everything you need, the cost is minimal and then if it all goes wrong it's not a problem to just start over.



AAARgh! Someone squished a spider. It's not pretty but it is working and it fits in the space available. I decided heat shrink over the long legs would be enough protection. They are pretty stiff and hopefully won't cause trouble despite being all over the shop.

A little brace bar goes between the two holes above and below the mayhem there. There is room for it to clear the prototype board but not any wires that go over it. So I trimmed a little notch in it in order to let those resistor wires clear it.

Back on the back side, you should be able to fit the Perspex bit on over the soldered terminals, there is a hollow space just in the right place. A bit of extra trimming of either the resistor ends or the Perspex cover might be needed though to get it to sit nicely.



And that's it. Should all fit back together and work fine.