Hi All,

The 3686 locomotive was manufactured over the period 1993-1996 (4 years) and the 3687 locomotive was over the period 1991-1993 (3 years). The 4301, 4302 and 4303 coaches were manufactured for the period 1990-1997 (8 years). All the above items were manufactured by Trix as a cooperative project with Märklin.

My aim is to eliminate the digital light flickering, the heat producing bulbs will be replaced by LED’s which will also reduce the power requirements for the locomotives and coaches.

**Locomotive 3686 and 3687**

The locomotive on the left shows the original lights with bulbs and although it may look prototypical the lights can’t be seen in a well light room.

The LED light upgrade on the right is not prototypical but looks good in a well light room.

The single photo shows two locomotives, a bulb and LED comparison.

**Warning:** - You undertake the following modifications at your own risk. A high level of soldering skill is required for the wiring of the LEDs and decoder.

Replacing the Bulbs for LED’s

These locomotives are extremely delicate and the handrails are renown by most people for breaking easily. First I carefully removed the body shell from the chassis then I removed all handrails to prevent any further breakages. My handrails on all these locomotives have received various breakages over the years.

The first photo shows the location of the bulb/LED holder for the rear lights. The wires were carefully unsoldered to allow removal of the light assembly. The bulb was removed by straightening the bent wires of the bulb which allowed the bulb to be pulled out of the red light mount. To fit a 3mm warm white LED into the hole I had to file the small collar off the LED. Once this was done I threaded the LED leads through the light mount with the anode on the left and the cathode on the right as shown. The leads were bent as shown then trimmed to a short length.

A short thin brown wire which was on the left (not shown) was removed and replaced with a grey ESU wire 100mm length which would be the +Plus for the LED to prevent digital flicker. The original F0 grey wire was resoldered to the cathode side of the LED.

To remove the light assembly at the front of the locomotive unsolder the wires then push the holding pin out (red arrow) this will allow the light holder to be easily removed. Replace the bulb with a 3mm warm white LED and note the orientation of the anode and cathode as shown.

As with the rear LED a short thin brown wire which was on the left (not shown) was removed and replaced with a grey ESU wire 100mm length which would be the +Plus for the LED to prevent digital flicker. The original F0 yellow wire was resoldered to the cathode side of the LED.

**Tip: LED Lighting Upgrade for 3686, 3687, 4301, 4302 and 4303**

Date: 26-11-2017

**Decoder Wiring Required Changes**

The LED’s require 1k current limiting resistors to be added and the +Plus supply will be obtained from the decoder diode bridge to supply flicker free power.

The grey wire connection from the anode of each LED is routed with the other existing wires to the decoder.

With the decoder removed from the holder the wires are soldered to the +Plus side of the diode bridge on the underside of the decoder as shown.

Care should be taken not to create any short circuits.

On the topside of the decoder the yellow and grey wires are unsoldered from the connection pads (see arrows).

A 1k resistor is soldered direct to the connection pads (see arrows) and the yellow and grey wires are shortened and then resoldered to other end of the resistors using heat shrink tube to prevent any short circuits.

Care should be taken not to create any short circuits before testing the light functions.

If you want to change the decoder address please refer to the link

*Solder Bridge Encoding Table*

With the testing complete the locomotive can be reassembled.

Tip: LED Lighting Upgrade for 3686, 3687, 4301, 4302 and 4303
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Coach Lighting for 4301, 4302 and 4303

Warning

Märklin provide a warning in the locomotive instructions only that coaches without the digital registration number can be damaged by overheating. Now it so happens I had one example of a non digital ready coach so I decided to measure the current consumption to find out the difference. It should be noted that the two coaches I have of the 4301 have the same packaging and text with no warning instructions.

Current Consumption Table

<table>
<thead>
<tr>
<th>Cat Number</th>
<th>Bulbs</th>
<th>LEDs</th>
</tr>
</thead>
<tbody>
<tr>
<td>4301 ~</td>
<td>55mA</td>
<td>4mA</td>
</tr>
<tr>
<td>4301 D</td>
<td>15mA</td>
<td>4mA</td>
</tr>
<tr>
<td>4302 D</td>
<td>15mA</td>
<td>4mA</td>
</tr>
<tr>
<td>4303 D</td>
<td>15mA</td>
<td>4mA</td>
</tr>
</tbody>
</table>

The current consumption of a train with a locomotive and x3 coaches before the LED light upgrade was approximately 52mA and after the LED light upgrade was 14mA so a big improvement.

Note how high the current for one analogue coach can be on a digital system = 55mA.

The heat generated from the bulbs was too hot to touch comfortably and even with the correct bulbs the heat generated was high. The lighting units have metal heat protectors which can be removed once the LED light conversion is done.

The baggage car on the left has dull bulb lighting and has digital light flicker and the baggage car on the right has brighter LED lights without the digital flickering.

Coach Lighting for 4303

I decided to start with the 4303 baggage car as it was the smallest car it would test if I could fit all the required electronics for improved LED lighting.

With the car body shell removed I could remove the lighting unit and disassemble it to remove the bulbs.

The pencil lines on the PCB indicate the no go zone (orange squares) where mounting components in this area wasn’t possible because of supporting ribs in the roof of the body shell.

Planning the LED light circuit on the existing PCB

![Diagram of the LED light circuit](http://members.ozemail.com.au/~rossstew/rms/marklin.html)

First I cut the copper foil of the PCB at the three locations marked with the red lines using my Dremel. Particular care must be taken to only remove the copper and not cut into the PCB. Use extreme caution when doing this process.

The only component not to have a fixed location is the capacitor as each coach has a different interior and hiding the capacitor from view requires finding a space where it won’t be seen.

All the other components have the same location on the PCB for all coaches.

The coach lighting is switched by a transistor in the locomotive so the circuit shown above is polarised and it is most important to get the orientation of the lighting assembly in the coach correct.

Note the “Ground” connection must be connected to the wheels and the “Switched Light Function” must be connected to the current conducting coupler.
Coach Lighting for 4303 continued

LED Tinting

The 3mm warm white LED’s which I have just received from China show a pink tinge to the light output. To cure this problem I used Tamiya Clear Yellow X-24 acrylic paint.

Below you can see the results.

With the light assembly complete it’s time to insert into the coach and position the capacitor equal distance between two windows as shown. Note the orientation of the diodes.
Tip: LED Lighting Upgrade for 3686, 3687, 4301, 4302 and 4303
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Coach Lighting for 4303 continued

With the light grey interior in the baggage car the pink tinge is noticeable but is cured after using the clear yellow acrylic paint.

Left photo with yellow tint added to LED. Right photo is without LED being painted.
Tip: LED Lighting Upgrade for 3686, 3687, 4301, 4302 and 4303  
Date: 26-11-2017

Coach Lighting for 4302

Capacitor Location Problem

Since I had soldered all the resistors and diodes for each light unit assembly the same I discovered that I needed to rotate the light unit 180° to get the capacitor positioned as shown above. This orientation was now electrically incorrect. The solution was to rotate the interior detail as it is symmetrical. The light unit assembly could now be fitted to be electrically correct.

I had to rotate the interior detail again to be able to position the capacitor as shown. Notice I used a wire for the negative connection to the capacitor.
Tip: LED Lighting Upgrade for 3686, 3687, 4301, 4302 and 4303
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Coach Lighting for 4301 continued

Left photo with yellow tint added to LED. Right photo is without LED being painted.

An end view of the coach shows the improved light output of the LED’s over the bulbs on the left. The LED’s at this stage haven’t been painted.

Running the Locomotive and Coaches as a Train

Running the train with three coaches worked well provided I only ran the train in one direction. I have 4.5% grades on my layout and I found that running the train in the opposite direction, the locomotive lost traction on a curve because the locomotive only has one traction tire.

The coaches are well made but heavy in relation to the small locomotive. I decided to take a few measurements to understand the problems.

Tip: LED Lighting Upgrade for 3686, 3687, 4301, 4302 and 4303
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Train Weights and Drawbar Pull.

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Catalogue Number</th>
<th>Weight or Drawbar Pull (gm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>4301</td>
<td>84</td>
</tr>
<tr>
<td>1</td>
<td>4302</td>
<td>82</td>
</tr>
<tr>
<td>2</td>
<td>4303</td>
<td>64</td>
</tr>
<tr>
<td></td>
<td>Total x5 car weight</td>
<td>378</td>
</tr>
<tr>
<td>1</td>
<td>Locomotive</td>
<td>108</td>
</tr>
<tr>
<td></td>
<td>Drawbar pull for 5 cars on a level surface</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Drawbar pull for one locomotive</td>
<td>25</td>
</tr>
</tbody>
</table>

Since the locomotives have a decoder without load control, one traction tire, they are close to the limit of being able to pull 3 coaches. I decided to use all 5 coaches and two locomotives as a push/pull configuration which worked well if I had both locomotives pointing away from the coaches. This gave me increased traction as a traction tire was on both rails and the combined drawbar pull of 50gm was able to move the train in either direction around my layout.

I seem to have a few of these locomotives.

Tip: LED Lighting Upgrade for 3686, 3687, 4301, 4302 and 4303
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Other examples of locomotive and coach lighting can be found under my Tips section.

For TrainAnimator I have provided 3686.yra, 3687.yra, 4301.yra, 4302.yra and 4303.yra files in supplied glasskasten.zip file.

As always enjoy your model trains.