

Tip: 2681/2881 King Wilhelm II Coach LED Lighting

Date: 26-03-2019, 22-03-2025

Hi All,

The **2681/2881 King Wilhelm II** is a one time release set manufactured in 1996-1997 as a cooperative project with Trix before it was taken over by Märklin. I have finally upgraded all coach lighting from bulbs which had a dull orange glow to warm LED lights to reduce the heat factor and increase the light intensity so the lights can be seen in a lighted room, the results can be seen below.

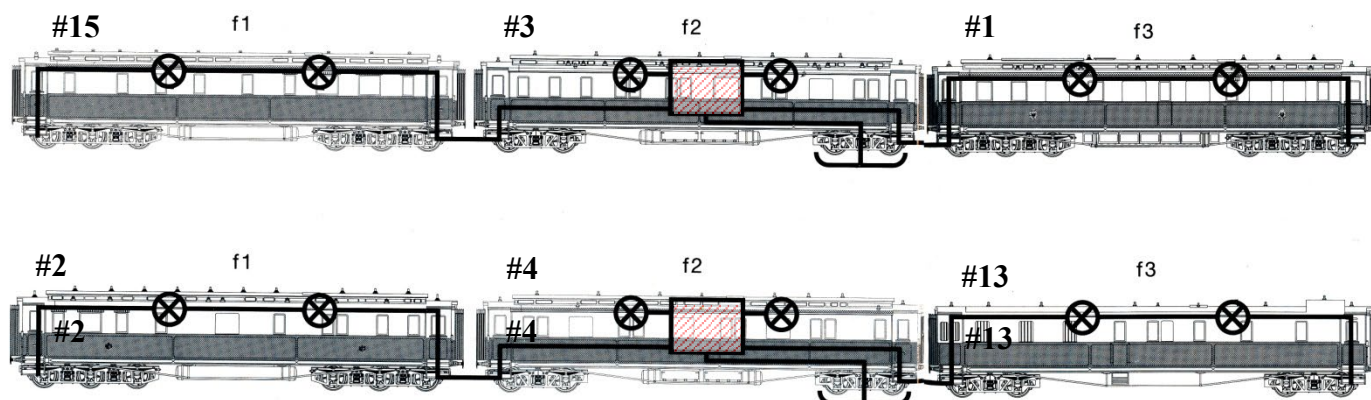


The lights for each coach can be switched on independently.

22-03-2025: - In the non-decoder coaches, I have replaced the single 1N914 diodes with a bridge rectifier to further reduce the digital flicker see pages 6-7.

See [Marklin 2681 King Wilhelm II Locomotive LP5 Upgrade](#) also.

Train Assembly



#x and #xx shown above are the car numbers.

The train consists of two groups of three coaches with the decoder coach at the centre of each group. Each decoder requires a Motorola protocol address and range is limited to a total of 15.

The default addresses are 10 and 11.

I use addresses **#3 = 16** and **#4 = 17** for my train.

Caution: - These coaches are very delicate with small detail parts that are easily broken or lost. Copying my method to add LED lighting is done entirely at your own risk. The decoder can be damaged if it is inserted into the coach with the incorrect orientation. Fine motor skills and patience are required to complete this project.

	Digital	ON	NO	1	2	3	4
#3	10	1	2	3	4		
#4	11	-	2	3	4		
	16	1	-	3	4		
	17	-	-	3	4		
	19	1	2	-	4		
	20	-	2	-	4		
	25	1	-	-	4		
	26	-	-	-	4		
	64	1	2	3	-		
	65	-	2	3	-		
	70	1	-	3	-		
	71	-	-	3	-		
	73	1	2	-	-		
	74	-	2	-	-		
	79	1	-	-	-		

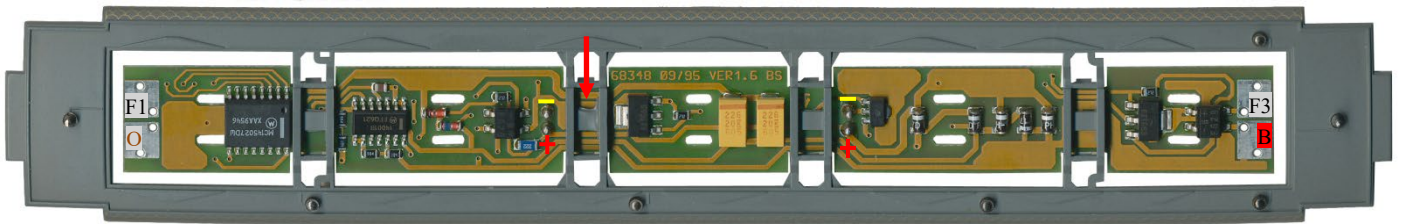
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Opening the Decoder Coaches

The **Gentlemen's Attendants #3** and **Ladies Attendants #4** coaches house the decoders but before rushing to open the coaches I wanted to make a note of the coach orientation and the decoder location in the coach.

The roof consists of two sections. I removed the top half to reveal the decoder below. For illustration purposes I have used a spare decoder to show the arrangement. The square pads at each end of the PCB are two pads for the power supply and two pads for the function outputs (**F1** and **F3**) but as they are not identified I had to find the correct connections. Finally, I wanted to measure the voltage and identify the positive and negative voltage connection to the bulbs so they can be wired to current limiting resistors and LEDs



Identifying the Power Connection Pads

Using a multi-meter to bell out the connection first for the power between the rails (O) and each pad I found the correct pad at the bottom lefthand corner. The next test was from the collector shoe (B) to one of the righthand pads which tested as the bottom righthand pad. I labelled the power pads as shown above.

Identifying the Function Connection Pads

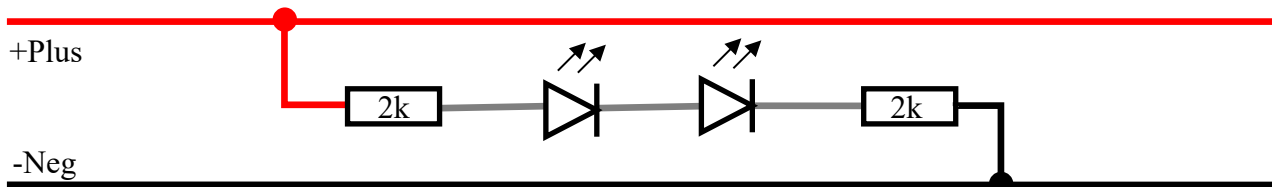
Couple a coach to the decoder coach and place on a track with digital power feed. Select the decoder address and switch on **F2**. The decoder coach should light. Now switch **F1** and **F2** on and note which function controls the coupled coach lights. Confirm by switching on/off the controlling function. The functions pads were labelled as shown above.

Identifying the +Plus and -Neg Bulb Connections

Set the multi-meter to dc volts and measure across the bulb sockets **being very careful not to create a short circuit**. I noted the voltage was **14.8Vdc** and marked the **+plus** side on the circuit PCB for each bulb socket as shown above.

As the voltage was high, I decided to use two 2k resistors to maintain a low light level for the PLCC2 warm white LEDs as shown in the diagram below.

Wiring Diagram Decoder Coach LED Lighting



The red arrow above indicates some heat damage to the plastic caused by the transistor **FZT653** just to the right of this area. Using LED lights, the transistor shouldn't get very warm as the current will be less.

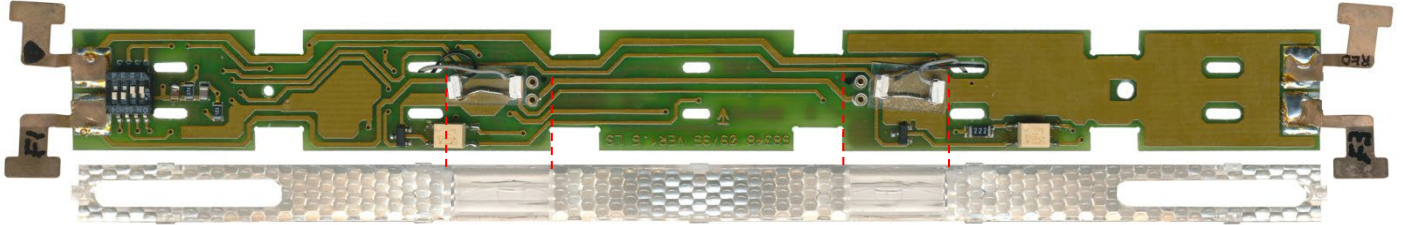
With the measurements complete carefully remove the bottom half of the roof with the decoder.

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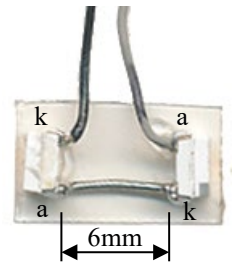
Decoder PCB Modifications for LED Lights

Carefully remove the decoder PCB from the roof section, unclip the light diffuser then remove the light two bulbs.



There is limited space to fit the LEDs when the light diffuser is clipped on to the PCB and to avoid any short circuits insulation under the LEDs is required.

Two PLCC2 warm white LEDs were soldered together anode to cathode by a solid wire to maintain a spacing of 6mm. A length of black flexible wire was soldered to the remaining cathode and a grey wire soldered to the last anode of the LEDs assembly. The LEDs were then super glued to a small thin plastic film to act as an insulator and also provide mechanical support.



On the top side of the PCB four 2k resistors were formed to the shape shown above and soldered to the bulb sockets. If you zoom in you will be able to see a small black dot which indicates the +plus connection for the LEDs.

Thread the wires from the LED assemblies through the slots on the PCB and cut to a suitable length to allow the heat shrink to be pushed onto the resistor to protect the solder joint as shown.



Carefully clip the light diffuser onto the PCB making sure the LED assemblies are positioned as shown and ensure you don't damage the wires in the process.

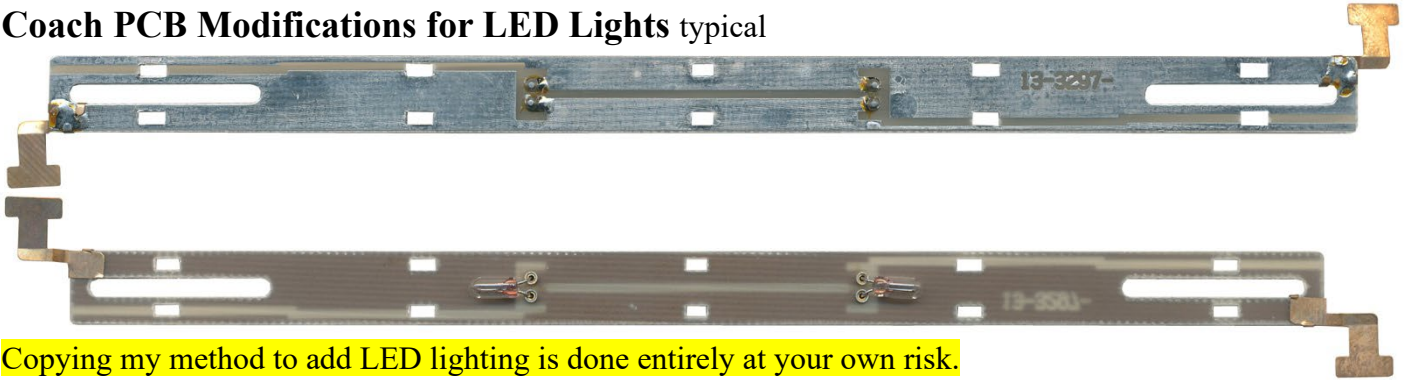


Mount the PCB into the roof making sure the orientation is correct then test the **F2** function to ensure the LEDs work. Finally clip the remaining roof half into place and the decoder coach is completed.

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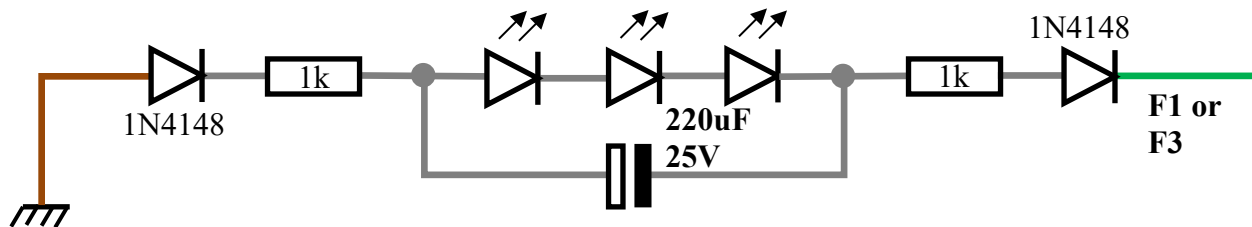
Coach PCB Modifications for LED Lights typical



Copying my method to add LED lighting is done entirely at your own risk.

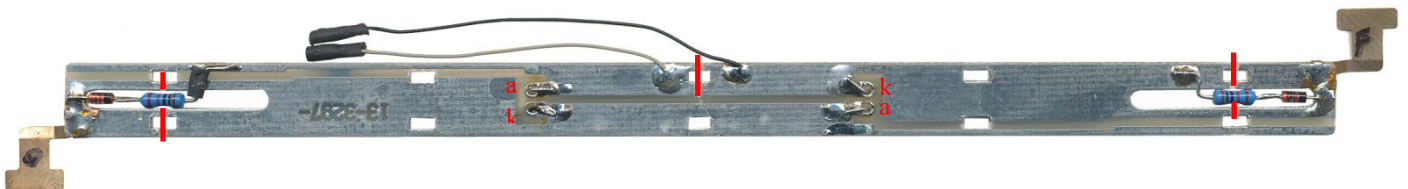
The PCB above is used for the **Dining #15**, **Kings #1** and **Queens #2** Coaches. After carefully removing the PCB from the coaches remove the bulbs then unsolder the sockets from the PCBs.

Wiring Diagram Typical Coach LED Lighting

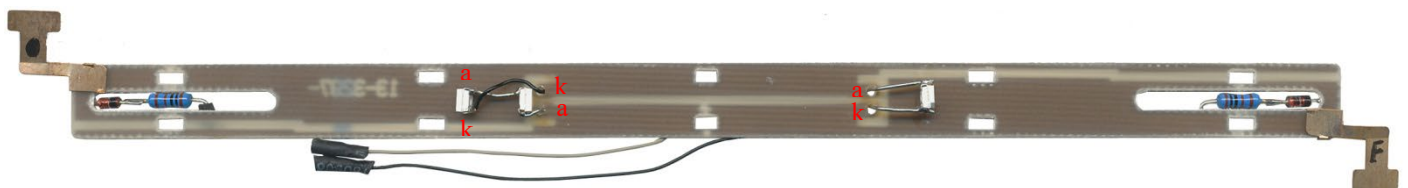


The above circuit is required for the coaches that couple to the decoder coaches. One of the PCB connectors is powered by the Gnd/Masse from the coach wheels and the other is connected to the switched function **F1** or **F3**.

When bulbs are used the PCB is non-polarised but for the LEDs to work the PCB will be polarised so the PCB must be marked to ensure correct orientation in the coach. To achieve the above circuit the PCBs will have to be modified.



The first thing to do is to mark the Gnd/Masse with a **dot** on the left PCB connector and **F** for the function on the right PCB connector. The **red** lines indicate where the PCB tracks need to be cut to create a gap, this is best done by making two cuts about 1mm apart with a sharp blade then using the soldering iron to heat between the cuts to remove the section to create the isolation gap. The diode and 1k resistor are first soldered together then they are formed to shape and soldered as shown. The resistor lead on the left is insulated with heat shrink to prevent a short circuit.



A LED assembly is created as previously mentioned and held in place with off cut resistor leads. All LEDs should be positioned as shown above. The wires with IC sockets are to reach where the capacitor is placed in the coach. The length of the wire will vary for each coach.

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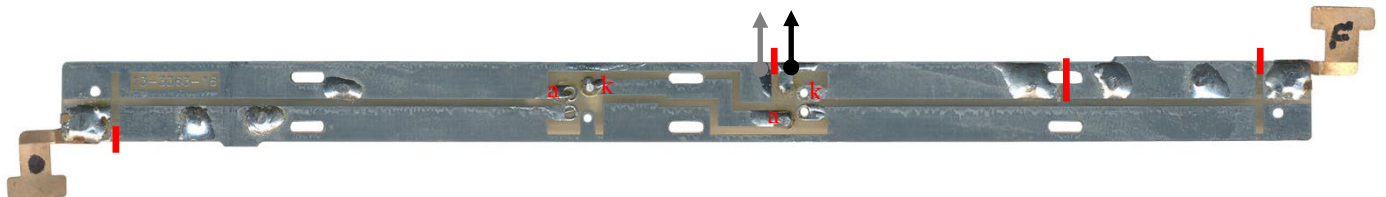
Coach LED Lighting Typical continued



Completed LED light PCB with light diffuser fitted.

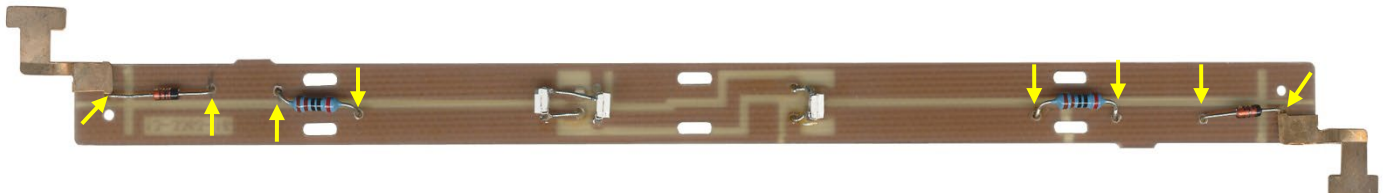
Baggage Car #13 LED Lighting

The baggage car is the only car that has a unique PCB for the lighting.
The grey and black arrows indicate the connection point for the capacitor.



Refer to the wiring diagram on page 4 for this PCB. The resistor values for this PCB are 2k.

Mark the Gnd/Masse with a **dot** on the left PCB connector and **F** for the function on the right PCB connector. The **red** lines indicate where the PCB tracks need to be cut to create a gap, this is best done by making two cuts about 1mm apart with a sharp blade then using the soldering iron to heat between the cuts to remove the section to create the isolation gap.



A 1mm drill was used to make mounting holes for the resistors and diodes see **yellow** arrows.

A LED assembly is created as previously mentioned and held in place with off cut resistor leads. All LEDs should be positioned as shown above. The wires with IC sockets (not shown see grey and black arrows) are to reach where the capacitor is placed in the coach. The length of the wire will vary for each coach.



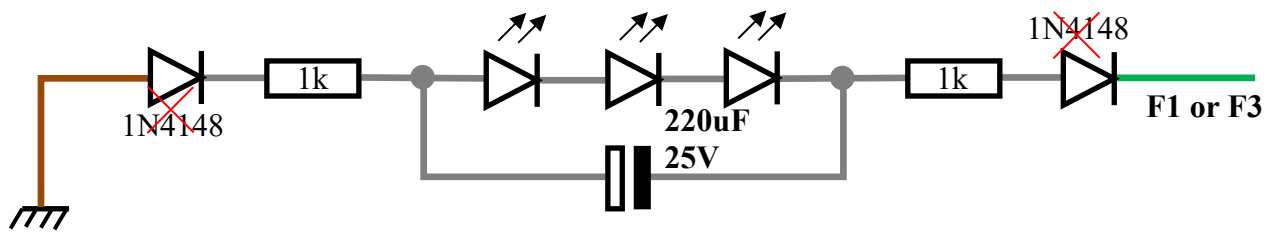
Completed Baggage Car LED light PCB with light diffuser fitted.

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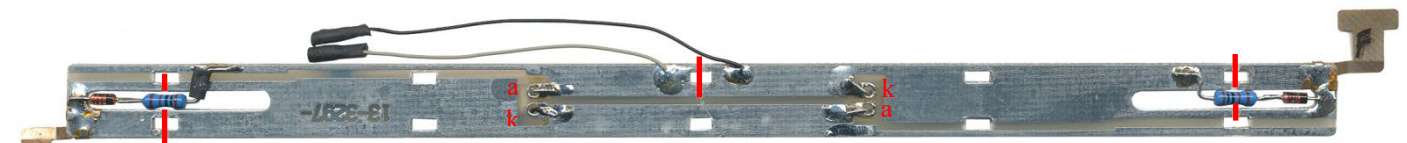
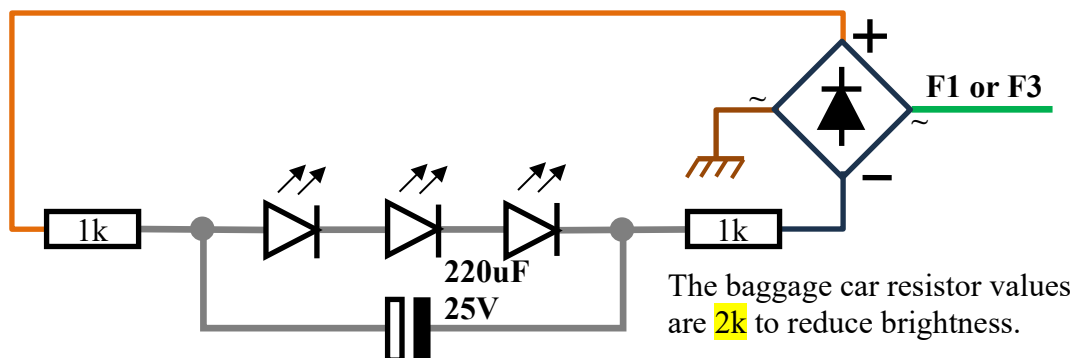
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Coach PCB Modifications with Bridge Rectifier for LED Lights typical

Original Wiring Diagram Typical Coach LED Lighting



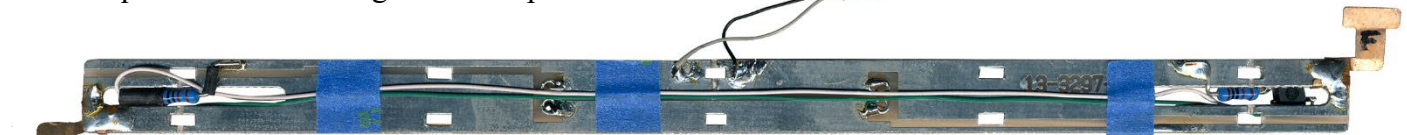
New Wiring Diagram with Bridge Rectifier Typical Coach LED Lighting



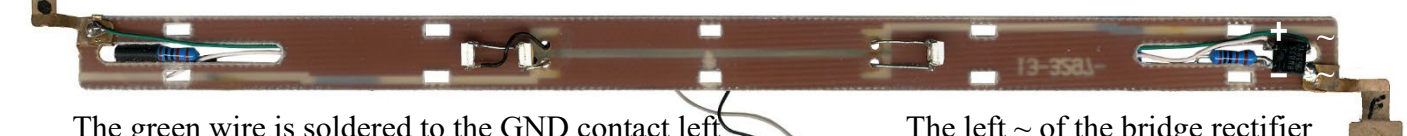
Original PCB modifications, the red cut lines still apply to the new assembly and the IN914 diodes will be removed.



The new PCB modifications below show two wires are required to run the length of the top side of the PCB.



The bridge rectifier is mounted at the function contact end of the PCB. The white positive wire is soldered to the resistor left side and the + of the bridge rectifier.



The green wire is soldered to the GND contact left side and to the right ~ of the bridge rectifier as shown.

The left ~ of the bridge rectifier is soldered direct to the F function contact. The resistor is soldered to the - negative of the bridge rectifier.

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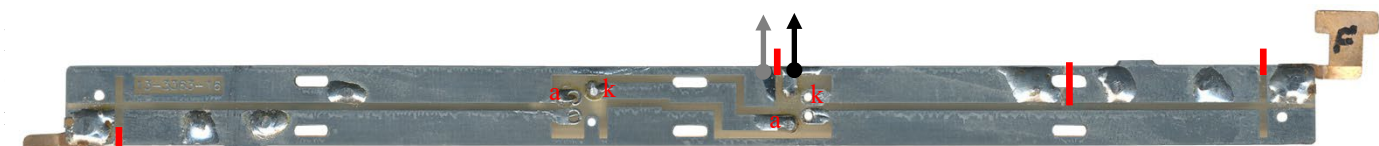
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Baggage Car #13 LED Lighting with Bridge Rectifier

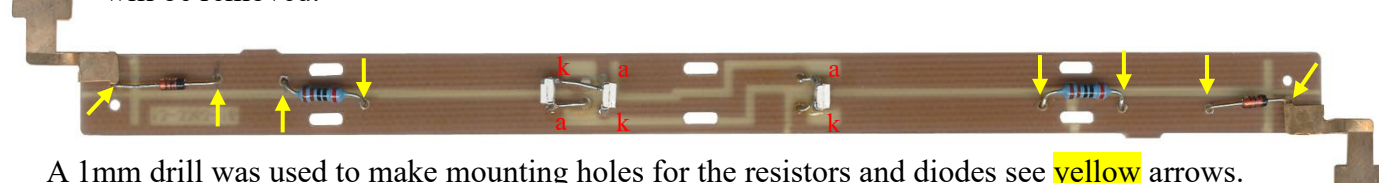
The baggage car is the only car that has a unique PCB for the lighting.

The grey and black arrows indicate the connection point for the capacitor.

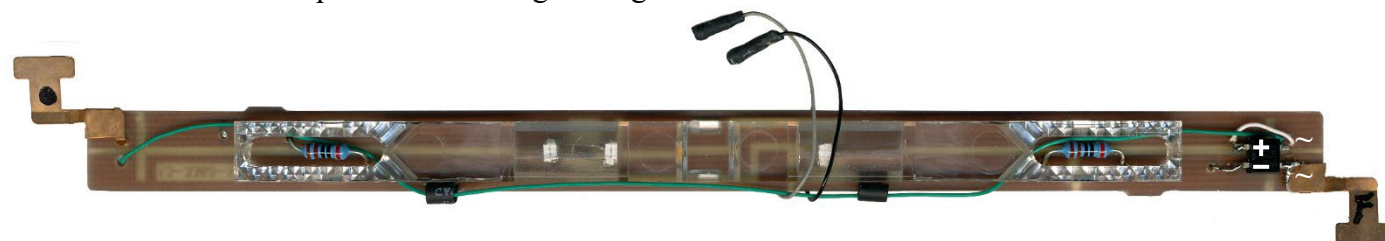
Refer to the wiring diagram on page 4. The resistor values for this PCB are **2k** to reduce brightness.



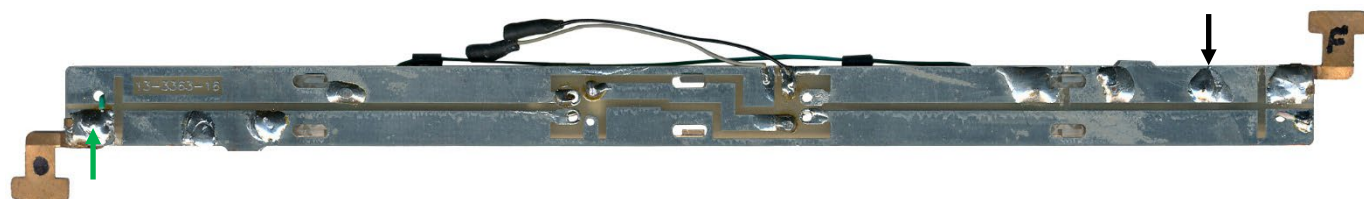
Original PCB modifications, the red cut lines still apply to the new assembly and the IN914 diodes will be removed.



A 1mm drill was used to make mounting holes for the resistors and diodes see **yellow** arrows. The diodes will be replaced with a single bridge rectifier see below.



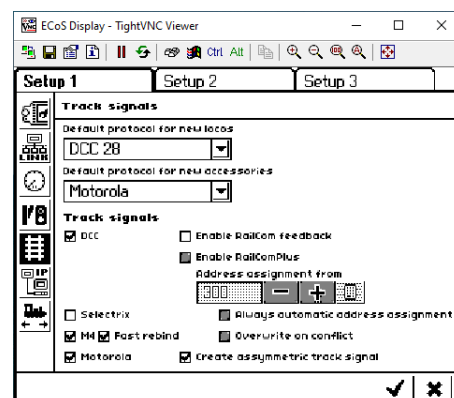
The final baggage car assembly with light diffuser fitted shows the green wire coming from the GND contact green arrow to the right ~ pad of the bridge rectifier. The white wire bridge rectifier + is threaded through a hole and soldered on the other side as shown. The left ~ pad of the bridge rectifier is soldered direct to the F function contact. The bridge rectifier - is soldered to a solid wire and goes through a hole, soldered to the black arrow location.



Why the Bridge Rectifier

I don't often run this train but in the last few weeks I have been running the train and found the coach lights had that familiar digital light flicker. I found that a setting in the ECoS, 'Create asymmetric track signal' had been switched off, it must have been me for some reason I don't recall.

The bridge rectifier is a great improvement and was well worth the effort to have nice steady lights without the digital flicker.



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Finding the Correct Electrical Connection in the Coach Typical

With all the lighting PCBs completed it's time to locate the correct electrical connection location in the Coach to match the lighting PCBs polarised connections.

A multi-meter is used to bell out the connection first for the power from the wheels (O) and the phosphor bronze contact in the coach, mark the location with a black **dot**. The next test is to measure between the couplings on the coach, these must be connected. Now make the last measurement between the current conducting couplings and the other phosphor bronze contact in the coach, mark this location with an 'F' for the function connection from the decoder coaches. See photos in the capacitor location section to see the **dot** and 'F' markings.

If you fail to get a connection as described above then you may have contact problems in the coach floor which happened to me and the coach has to be disassembled.

Body Shell



The **brown** arrow with black dot is the Gnd/Masse connection from the wheels and is common with the blue wheel contact area.

The **green** arrow is the location of the phosphor bronze contact in the coach which is common with the coupling contact area **yellow** arrows which is for the function contact 'F'

The **blue** arrows are the wheel contacts which I polished with 1200 grit sand paper and bent up slightly to apply more pressure to make good contact with the wheel bogies.

At the location of the **yellow** arrows the coupling contact areas were polished with 1200 grit sand paper.

Chassis



The coupling pocket contacts **orange** arrows I polished with 1200 grit sand paper and bent up slightly to apply more pressure to make good contact with the coupling contact area.

The **blue** arrows are the wheel bogie contact points.

It is most important to ensure the coupling return centre springs are fitted as shown. Don't lose them.

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Coach Capacitor Locations

Baggage Car #13



This photo shows the orientation of the lighting PCB to the **dot** and **'F'** on the car. The capacitor is positioned in a corner of the car away from windows so it can't be seen.



The wires from the light PCB are plugged onto the capacitor leads and then the lighting PCB can be clipped into place. Finally, the roof can be installed.

Dining Car #15



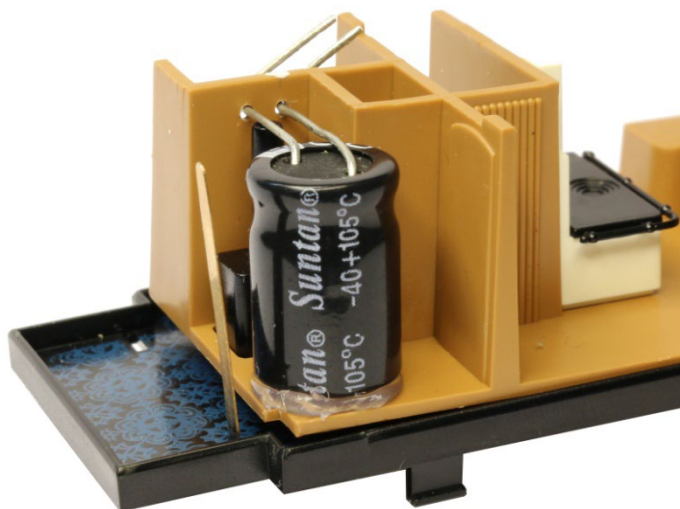
The dining car is the most difficult car to conceal the capacitor as it is open plan. To get the capacitor concealed I had to dismantle the car to be able to drill some holes and position it in the corner as shown.

Note the orientation of the lighting PCB to the **dot** and **'F'** on the car. When the roof is clipped on ensure the wires are concealed and not damaged.

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Dining Car #15 continued



The capacitor is held in place with hot melt glue and the leads of the capacitor pass through two 1mm holes where the leads are formed to allow the PCB wires to plug onto the capacitor. The photo on the right shows the body shell fitted and you can see the capacitor is a tight fit.

Queens Car #2



Note the orientation of the lighting PCB to the **dot** and **'F'** on the car. I found a convenient place to hide the capacitor.

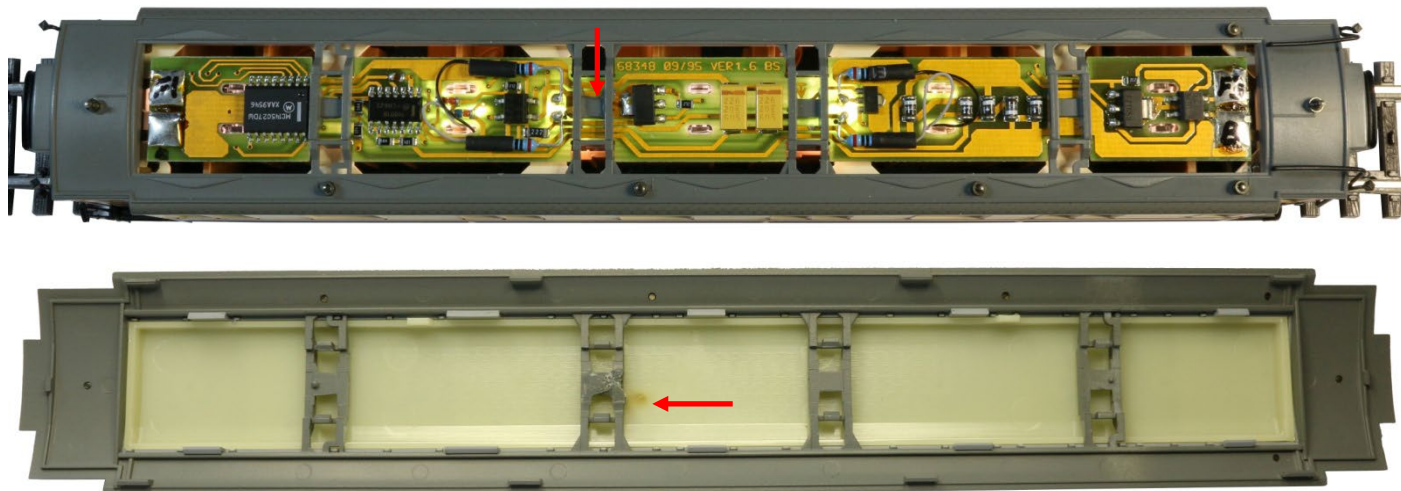
Kings Car #1 For the Kings car I managed to locate the capacitor between two windows so it wouldn't be seen.



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Decoder Coaches Heat Damage



The red arrows above indicate some heat damage to the plastic caused by the transistor **FZT653** just to the right of this area. Using LED lights, the transistor shouldn't get very warm as the current will be less.

Facts Section

The table below shows weights and drawbar pull for the King Wilhelm II train

Car #	Description	Weight gm	Drawbar Pull gm
15	Dining Car	178	
3	Gentlemen Attendants	178	
1	Kings Car	178	
2	Queens Car	176	
4	Ladies Attendants	180	
13	Baggage Car	158	
1008	S10 Locomotive	552	
	Total Train Weight	1600	
	Drawbar Pull Level Track		30-25
	Drawbar Pull 2.5-3% Grade		70

Two bulbs in series, current draw is **20.21mA**

Three LEDs in series current draw is **2.1mA**

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LED and Bulb Final Photos

The LED photo is the top photo of each group and the bulb photo is below for each group.

Dining Car #15



Oops the bulb photo is showing the other side

Gentlemen Attendants #3



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Kings Car #1



Queens Car #2



Oops I forgot to clip the roof on correctly but it still shows the bulb illumination.

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Ladies Attendants #4



Baggage Car #13



As always enjoy your model trains.