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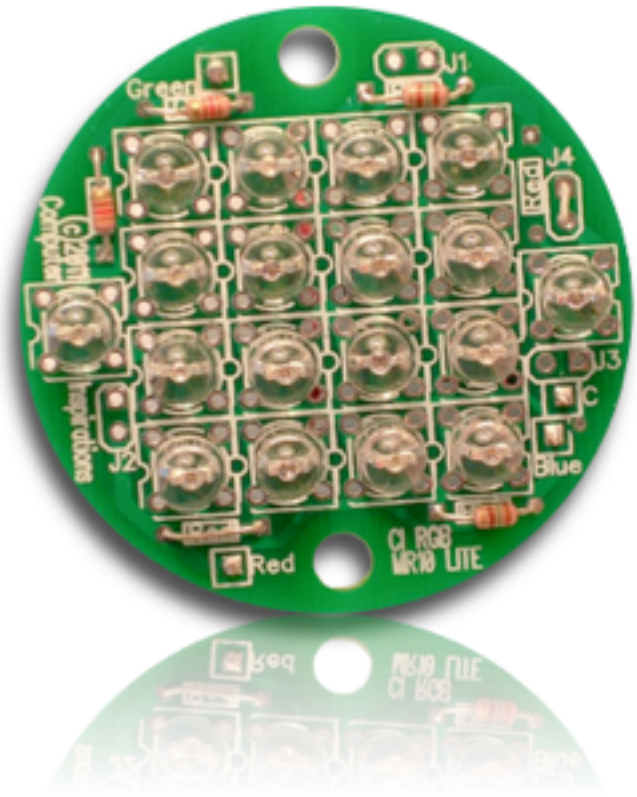
RGB MR-16 LED PCB



ASSEMBLY INSTRUCTIONS & TECHNICAL MANUAL

Thursday, 5 May 2011

RGB LED PCB Assembly Instructions & Technical Manual

Description

The RGB MR-16 PCB is a LED-based luminaire which can be easily customized with the following options:

- Three-colour light assembly using 3 or 6 LEDs per colour;
- Single-colour light assembly using either 9 or 18 LEDs in your choice of colour;
- Use either 2-pin 5mm or 4-pin Piranha-style (single-colour) LEDs.

PCBs are populated with each colour having two sets of three LEDs with a single current-limiting resistor per set. Any LED colour is possible but the basic RGB kit comes with six red, six blue, and six green 5mm LEDs while the white kit comes with 18 5mm LEDs.

The resistors included with our kits are intended for 12V operation and will produce approximately 20mA per set of three LEDs for a total of 120mA per board with 18 LEDs installed. It is possible to operate with other voltages as long as the minimum power supply voltage is greater than the sum of the individual LED forward voltages (e.g., with red LEDs where V_f = 2.0 V, the minimum voltage would be 6V for each set of LEDs). For a 20mA current in each LED string, the appropriate resistor value for each set of three LEDs, R, is calculated from:

$$R = 50(V_b - 3V_f)$$

For this example V_b = 8V, so the resistor value would be 50(8-6) = 100Ω. Select the closest available resistor which is greater than or equal to the desired value. If installing in an automotive application, please be aware that the battery voltage can vary by up to 15V so use this value for the V_b value.

The red, green, blue, and white LEDs included with our kits have the following V_f values:

LED	TYPICAL V_f	12V RESISTOR
Red (RGB Kit)	2.0V	300Ω
Green (RGB Kit)	3.2V	120Ω
Blue (RGB Kit)	3.0V	150Ω
White (White Kit)	3.2V	120Ω

If you require different resistors, be sure to use only the ¼ watt miniature resistors (i.e., 1.70mm x 3.20mm)—other resistors are too large to fit on this PCB.

Another consideration that will limit the maximum voltage is the power rating of the resistors. The worst-case power dissipation in the red resistors (¼ W) limits the maximum voltage to:

$$V_{\max} = \frac{25}{2} + 3V_f = 18.5$$

This maximum voltage can be increased by either placing the red LED strings in series or using another LED in place of the red with a higher V_f value. Refer to the *Technical Description* below.

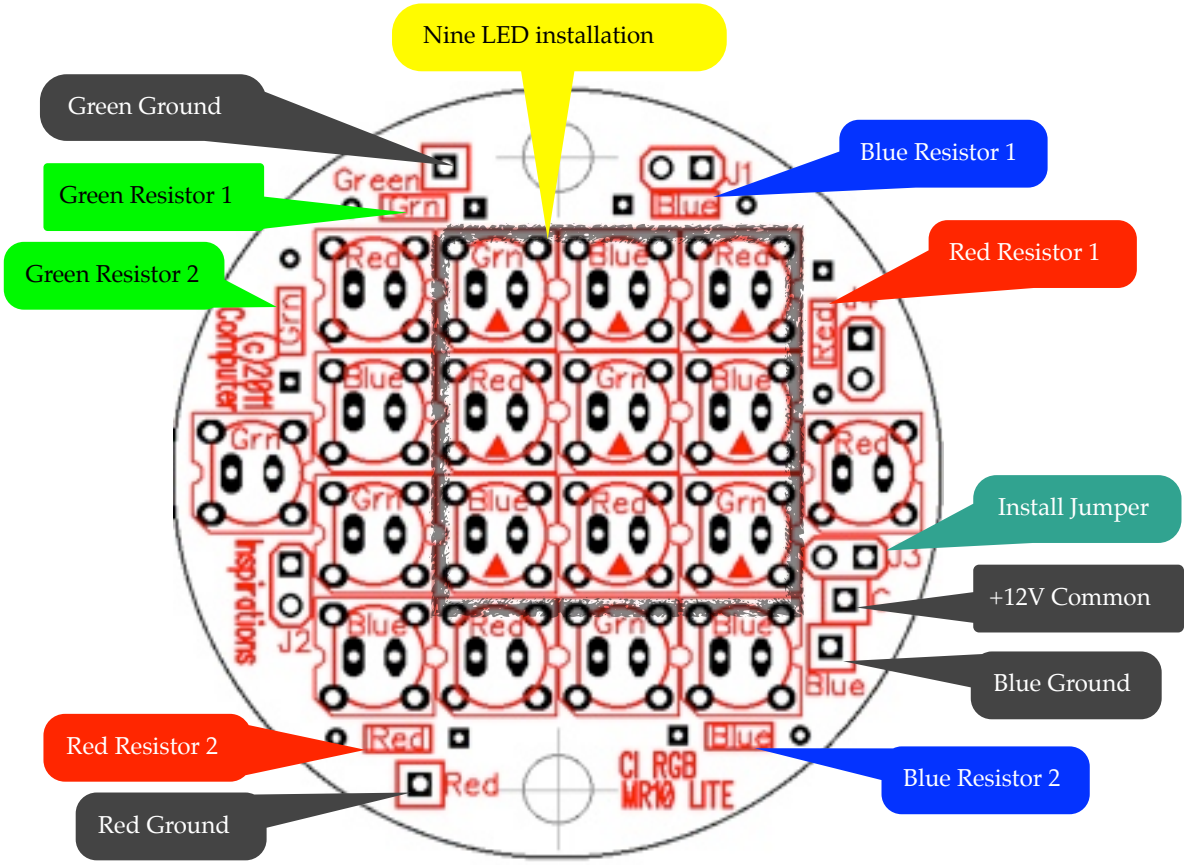
Assembling the RGB PCB Kit with 18 LEDs

Please verify that your kit contains the following parts:

1. 2 – 300 Ω ¼ W resistors
2. 2 – 150 Ω ¼ W resistors
3. 2 – 120 Ω ¼ W resistors
4. 6 – 5mm red LEDs
5. 6 – 5mm green LEDs
6. 6 – 5mm blue LEDs
7. 1 – RGB MR-16 PCB

Assemble and solder these parts in the following order (refer to PCB outline below):

- ☐ Cut a 1cm length from one of the resistor leads and solder across J3.
- ☐ 2 – 300 Ω LED resistors where the Red resistors are located.
- ☐ 2 – 150 Ω LED resistors where the Blue resistors are located.
- ☐ 2 – 120 Ω LED resistors where the Green (Grn) resistors are located.
- ☐ 6 – 5mm red LEDs as marked (**Important: notch goes to the left as shown**).
- ☐ 6 – 5mm blue LEDs as marked (**Important: notch goes to the left as shown**).
- ☐ 6 – 5mm green LEDs as marked (**Important: notch goes to the left as shown**).
- ☐ Connect three wires to Red (R), Green (G) and Blue (B) ground points as marked.
- ☐ Connect one wire to the LED +12V common power supply as marked.



Assembling the White PCB Kit with 18 LEDs

Please verify that your kit contains the following parts:

1. 6 – 150 Ω ¼ W resistors
2. 18 – 5mm white LEDs
3. 1 – White MR-16 PCB

Assemble and solder these parts in the following order (refer to PCB outline above):

- ☐ 3 – 1cm lengths from the resistor leads and solder across J1, J2, and J3.
- ☐ 6 – 150 Ω LED resistors where the Red, Blue, and Green (Grn) resistors are located.
- ☐ 18 – 5mm white LEDs as marked (**Important: notch goes to the left as shown**).
- ☐ Connect one ground wire to either the Red (R), Green (G) or Blue (B) LED ground point as marked.
- ☐ Connect one wire to the LED +12V common (C) power supply as marked.

Assembling the PCB with 9 LEDs

Please purchase the following parts:

1. 3 – Suitably-valued ¼ W resistors (1.70mm x 3.20mm size, through-hole)
2. 9 – 5mm or Piranha LEDs (your choice but keep similar colours in one set)
3. 1 – RGB MR-16 PCB

Assemble and solder these parts in the following order within the *Nine LED* area (refer to PCB outline above):

- ☐ 3 – LED resistors where the Red 1, Blue 1, and Green 1 resistors are located
- ☐ 9 – 5mm LEDs as marked in the *Nine LED* area (**Important: notch goes to the left as shown**)
- ☐ Connect three wires to Red, Green and Blue LED ground points as marked
- ☐ Connect one wire to the LED +12V common power supply as marked

Testing the Assembled Board

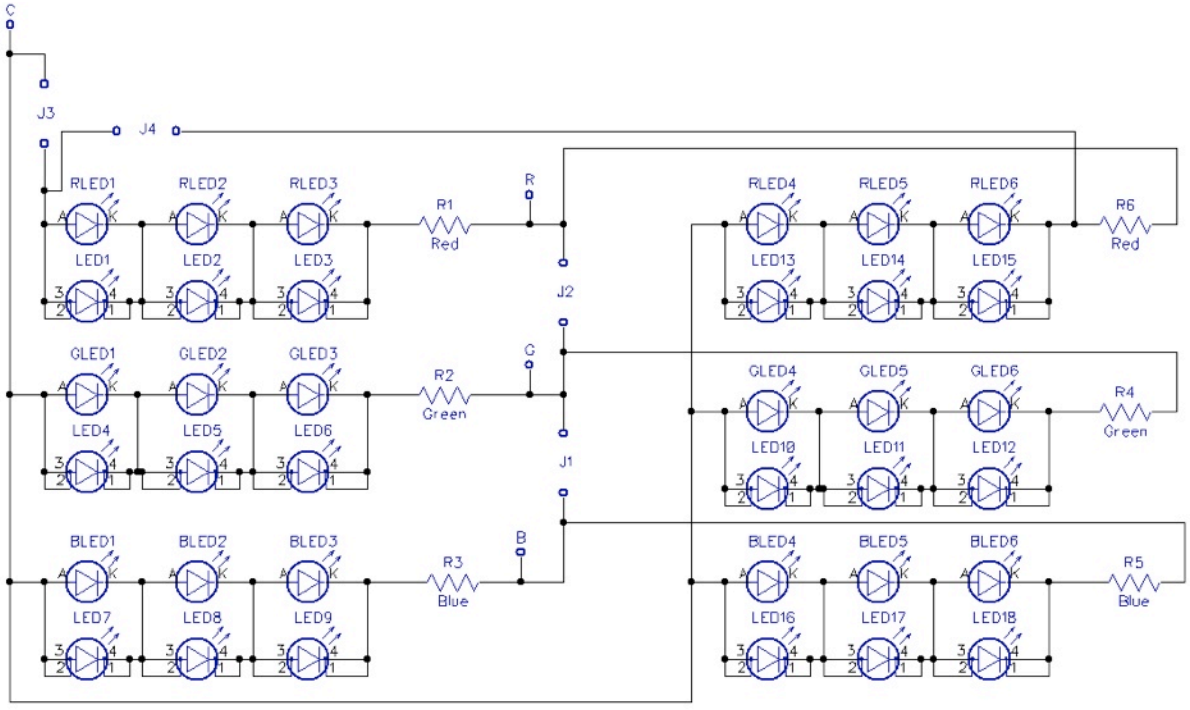
Once the components have been soldered to the PCB, test the assembly, preferably with a current-limited 12V power supply.

1. Connect the +12V power supply lead to the Common (C) lead from the MR-16 board.
2. Connect the ground power supply lead to each of the Red (R), Green (G), and Blue (B) wires, while monitoring the current consumption using an ammeter or the power supply's current indication. Each colour should have a current of about 40mA (two sets of three series LEDs). Ensure all the LEDs on the board light up when power is applied.
3. Trouble-shooting. If any LEDs don't light, check the following:
   a. Are the required jumpers in place?
   b. Have all the required resistors been installed?
   c. Have all the LEDs been installed with the notch oriented correctly?
   d. If using just nine LEDs are they installed in the appropriate *Nine LED* area?
   e. If you suspect one defective LED in a string, apply about 2 - 3V across each LED (notched side is ground). Keep the voltage close to the recommended V_f from the table above or use a 1K Ω resistor in series with the 12V power supply.

Technical Description

The circuit diagram below shows the MR-16 schematic. Eighteen LEDs are connected in series with three LEDs in each group. Either 5mm (RLED1 – RLED6, GLED1 – GLED6, BLED1 – BLED6) or piranha (4-pin) LEDs (LED1 – LED18) can be populated on the board. Current is limited to 20mA by the series resistors (R1 – R6) for each set of LEDs. Jumpers (J1 – J4) enable different options as summarized below:

JUMPER(S)	FUNCTION
J3	Installed for normal Red LED operation where LEDs are connected in two separate series groups.
J4	Installed for series-connected Red LEDs where all red LEDs are connected in one string. Neither J3 nor R6 should be installed in this configuration.
J1, J2	Installed for a single-colour LED populated in all positions. These jumpers tie together all the LED series to be grounded from one point — either R, G, or B.



RGB MR-16 Circuit Schematic.

Normal polarity of the LEDs, as shown in the schematic, provides a common positive supply point at C and grounding points for each of the colours red (R), green (G), and blue (B). If this circuit is to be driven by a controller with a common ground, simply reverse all the LEDs during assembly. In that case, the ground connection will be at C and the positive supply at each of R, G, and B. Note: The RGBW Controller we provide requires the default LED assembly with a common positive supply.

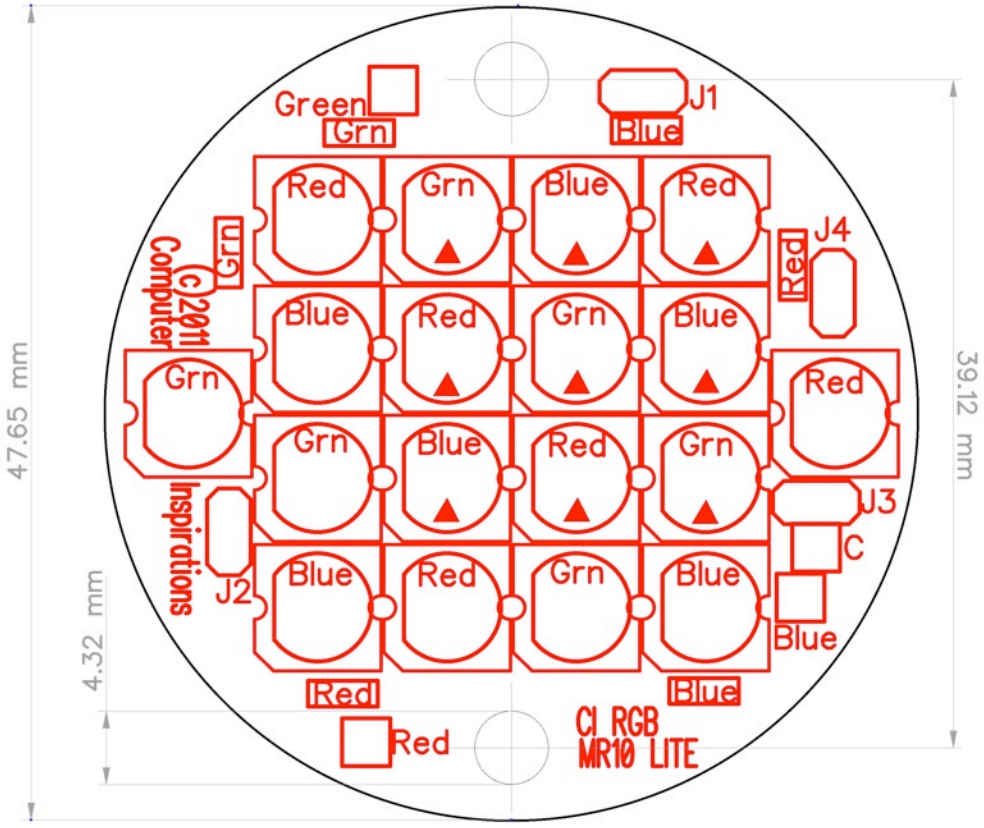
The table below summarizes the electrical characteristics of the RGB MR-16 circuit:

PARAMETER	MINIMUM	NOMINAL	MAXIMUM
V_b (Supply Voltage)	3 V_f – 6 V_f See text.	12V	18.5 – 21.5V See text.
I_b (Total Current) 18 LEDs	—	—	120 mA
I_b (Total Current) 9 LEDs	—	—	60 mA
I_b (Total Current) 18 LEDs, Red in Series	—	—	100 mA
Total Power	0.72 W (9 LEDs)	1.44 W (18 LEDs)	2.15 W @ 21.5V
Total Light Intensity (RGB LED kit)	78,000 mcd (9 LEDs)	—	156,000 mcd (18 LEDs)
Viewing Angle (RGB LED kit)	160°	—	180°
Total Light Intensity (White LED kit)	234,000 mcd (9 LEDs)	—	468,000 mcd (18 LEDs)
Viewing Angle (White LED kit)	—	15°	—

The maximum allowable supply voltage, V_{max}, is given by:

$$V_{\max} = \frac{P_r}{I_f} + 3V_f$$

where I_f is the LED forward current (usually 20 mA), P_r is the resistor's maximum power rating (¼ W), and V_f is the LED's forward voltage. Usually this equation is dominated by the red LEDs' current-limiting resistance since they have the lowest V_f and consequently the highest voltage drop across the series resistor. It is possible, however, to place the two red LED strings in series by installing jumper J4 instead of J3. The V_{max} is then 21.5V instead of 18.5V with the normally-connected red LEDs. A desirable side effect of the red LEDs being connected in series is that the total supply current is reduced to 100 mA with no loss in brightness. The minimum voltage, however, will be $6V_f$ or about 12V. Generally, there is no advantage to using supply voltages higher than 12V since the extra power will be wasted in the current-limiting resistors.



Mechanical Dimensions of the RGB LED PCB