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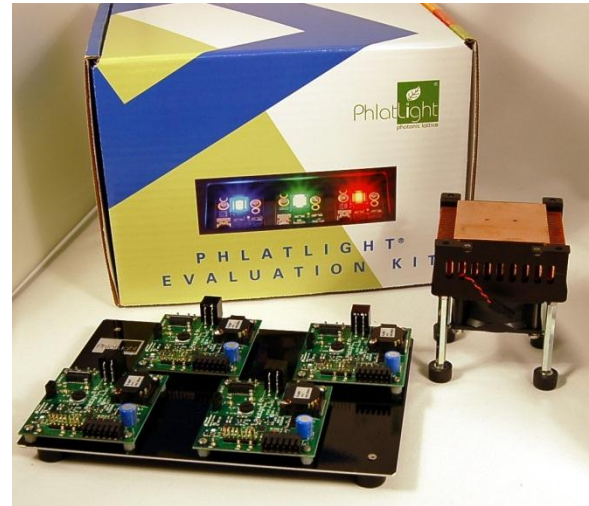
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DK-414N-4 Development Kit Manual



Introduction:

Luminus Devices's LEDs have been designed from the ground up to enable a new class of illumination and projection systems. Benefiting from a suite of innovations in chip technology, packaging, and thermal management, these LEDs allow designers to achieve efficient light engine designs and deliver high brightness solutions.

The DK-414N-4 Development Kit was designed for fast and simple evaluation of the CBM-380 LED. The electrical and thermal solutions included in the kit enable customers to easily breadboard or prototype their system without time consuming and costly development of driver boards and heat sinks.

Designed to work with the CBM-380 and capable of providing up to 14 A per channel, the development kit supports various drive conditions and use scenarios.

This plug and play solution can easily be connected to common laboratory equipment through standard connectors and allows system designers to save weeks in their development cycles.

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1. Key Features

- Drives each color of CBM-380 to full power
- Pulse frequencies up to 40 kHz
- Analog current control via on-board potentiometer or external voltage
- Simple current and voltage monitoring
- Fast rise and fall times - less than 1 microsecond
- Fast current level switching - less than 5 microseconds

2. Development Kit Contents

The DK-414N-4 Development Kit includes the following components, as shown in Figure 1:

- Heat sink
- Driver boards
- Cable assemblies
- Thermal interface material and mounting hardware
- User manual

A list of contents of the development kit is given in Appendix A. This development kit is designed with flexible features to allow easy evaluation of the CBM-380 LED but is not optimized for size or for direct integration into end products. However, the underlying circuit and thermal design can be used as a reference by system designers; to this effect, design files including schematics, mechanical drawings, and bill of materials are available upon request. The CBM-380 is built with a common anode configuration (refer Appendix B). To enable driving the CBM-380, the driver circuit, based on National Semiconductor's LM3433 IC, is configured in the grounded common anode topology. This topology enables the anodes of multiple LEDs to be in electrical contact with each other without necessitating electrical isolation. Further design support for the driver can be obtained at <http://www.national.com>.

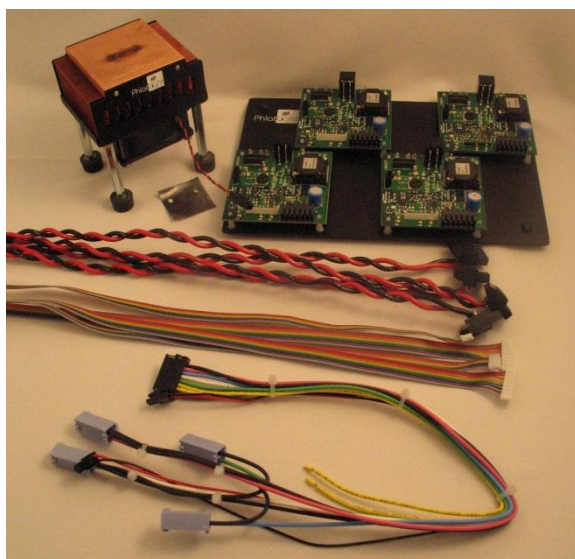


Figure 1: DK-414N-4 Development Kit Contents

2.1 Heat Sink

The heat sink is a high performance, low cost, compact air cooled copper sub mount with copper fins and a bolt pattern in the front that enables easy mounting of the CBM-380 modules. The typical thermal resistance from heat sink to ambient with the fan in operation is 0.3 °C/W, thereby enabling significant power dissipation.

2.2 Driver Board

Due to the grounded common anode topology, each driver requires a -12 V DC input, and can provide drive currents up to 14 A to one LED in a CBM-380. The driver board is capable of driving the LEDs in either CW or pulsed mode. PWM dimming is achieved with a 0-5 V signal from a function generator and frequencies up to 40 kHz are supported.

Figure 2 depicts the layout of the driver board along with the pins and commonly used readouts. The signal pins are used to achieve external current control and provide PWM dimming; the orientation of these pins is also shown, starting with pin 1 on the left. Table 5 lists the pin-out for the signal pins.

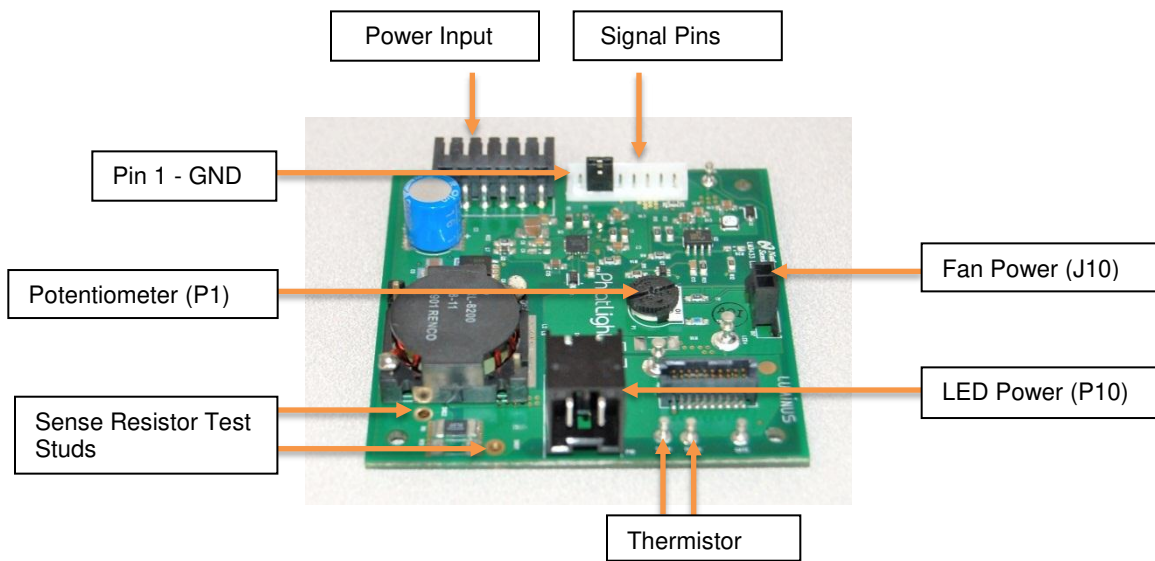


Figure 2: Driver board layout.

2.3 Cable Assembly

Each development kit includes the following cables:

- Power supply to driver board cable
- Driver board to LED cable (with a fan cable)
- Signal cable

For optimum performance, and to avoid ringing when pulsing the LEDs, increasing the length of the driver board to LED cable is not recommended. The figures below illustrate the cables included in the development kit.



Figure 3: Power supply to driver board cable

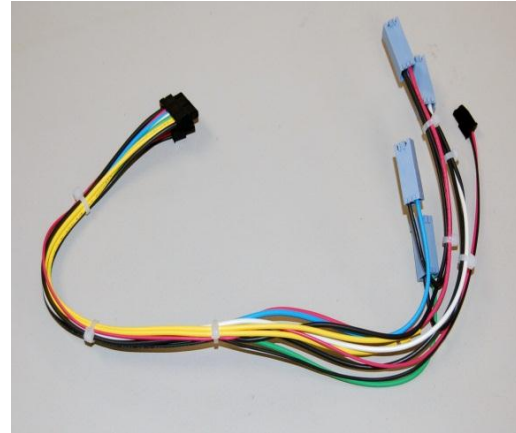


Figure 4: Driver board to LED cable

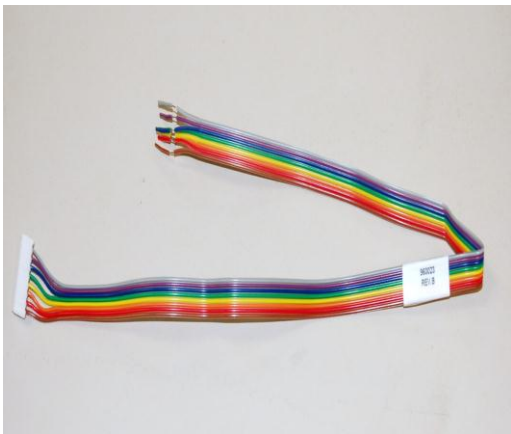


Figure 5: Signal cable

2.4 Thermal Interface Material (TIM) and Mounting Hardware

Also included in the kit are two precut sheets of eGraf HiTherm 1205, a high performance thermal interface material, and M2.5x6 screws, required for mounting the LED.



Figure 6: TIM sheet

3. User Instructions

The following procedures explain how a DK-414N-4 Development Kit is setup. It is recommended that the table used be equipped with ESD protection.

3.1 Equipment Required by User

In order to power and use the development kit, additional equipment is required. Table 1 lists the additional equipment required along with a recommended model. An additional list of compatible power supplies is provided in Appendix C.

| Lab Equipment | Recommended Model |
|----------------------|---------------------|
| 12V Lab Power Supply | Lambda ZUP20-20 |
| Oscilloscope | Tektronix TDS 3024B |
| Waveform Generator | Agilent 33220A |
| Multimeter | Fluke 187 |
| Photodetector | Thorlabs PDA10A |

Table 1: Additional Lab Equipment

3.2 Device Mounting Instructions

Ineffective heat sinking may lead to premature LED degradation or failure. The following steps explain how a device is mounted on the heat sink while ensuring good thermal contact between the copper core-board and the heat sink:

1. Use a thermal interface sheet that is slightly larger than the core-board (Figure 7).

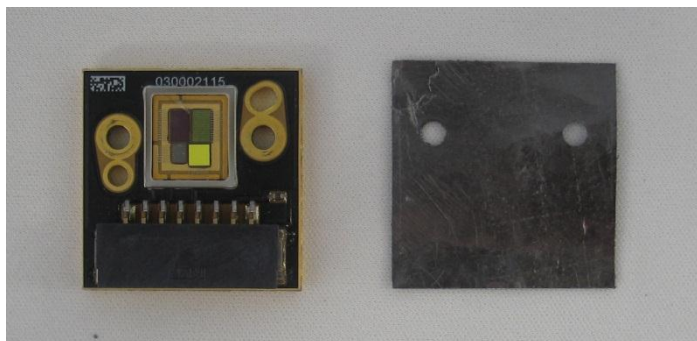


Figure 7: CBM-380 and an appropriate TIM sheet

2. The heat sink surface must be free of dust particles. Place the thermal interface sheet on the heat sink with its pre-drilled holes matching the holes on the heat sink (Figure 8).

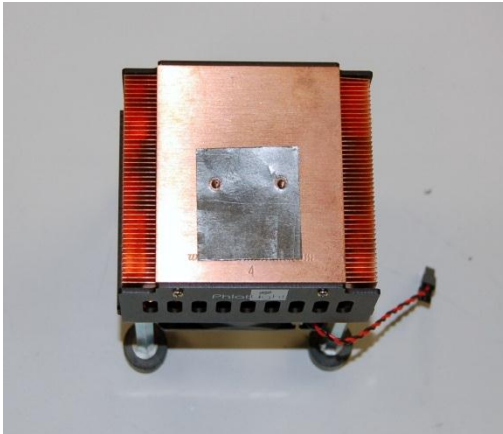


Figure 8: Thermal interface sheet on heat sink

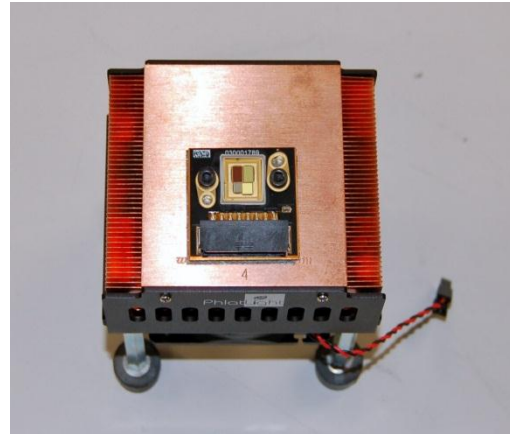


Figure 9: Device mounted on heat sink

3. Place the device on the thermal interface sheet.
4. Insert screws in the holes of the coreboard and tighten. To ensure equal pressure is exerted by all screws, alternate tightening each screw until the board is securely fastened. The device is now mounted and ready for electrical connections (Figure 9).

3.3 Electrical Connections

The following sections assume that the user has all the equipment listed in Table 1.

1. Each of the four LEDs in the CBM 380 can be driven at 9-12 A and the power supply being used must be capable of providing sufficient power to drive the CBM-380. Preset the output voltage to 0 V and keep the power supply switched off until all connections are established.
2. Connect the driver boards to the LED and the power supply using the cables provided in the kit (Figure 10). Consult Appendix F for the LED electrical pin-out to determine which color each driver board would be controlling. The driver board to LED cable connects to the driver boards at P10 and has thermistor connections from the LED, which can be connected to test points THRM1 and THRM2 on any driver board, if necessary. The short 2-pin fan cable must be connected to one of the driver boards at J10.
3. Use the jumper provided with the driver board to short signal pins 2 and 3 (see Figure 1 and Table 5). These pins correspond to Analog ADJ and POT; shorting them enables the on-board potentiometer. Alternatively, the jumper can be removed and signal cable can be used to short the Analog ADJ and POT pins.
4. Set the POTs to the minimum current setting by rotating them fully counter-clockwise. The embedded arrow should point towards the “10” on the POT.
5. The development kit is now ready to be powered on. Turn on the power supply and increase the source voltage to -12 V. The driver will draw about 1-2 A current.

CAUTION: Do not set the power supply higher -12 V; doing so may damage the driver.

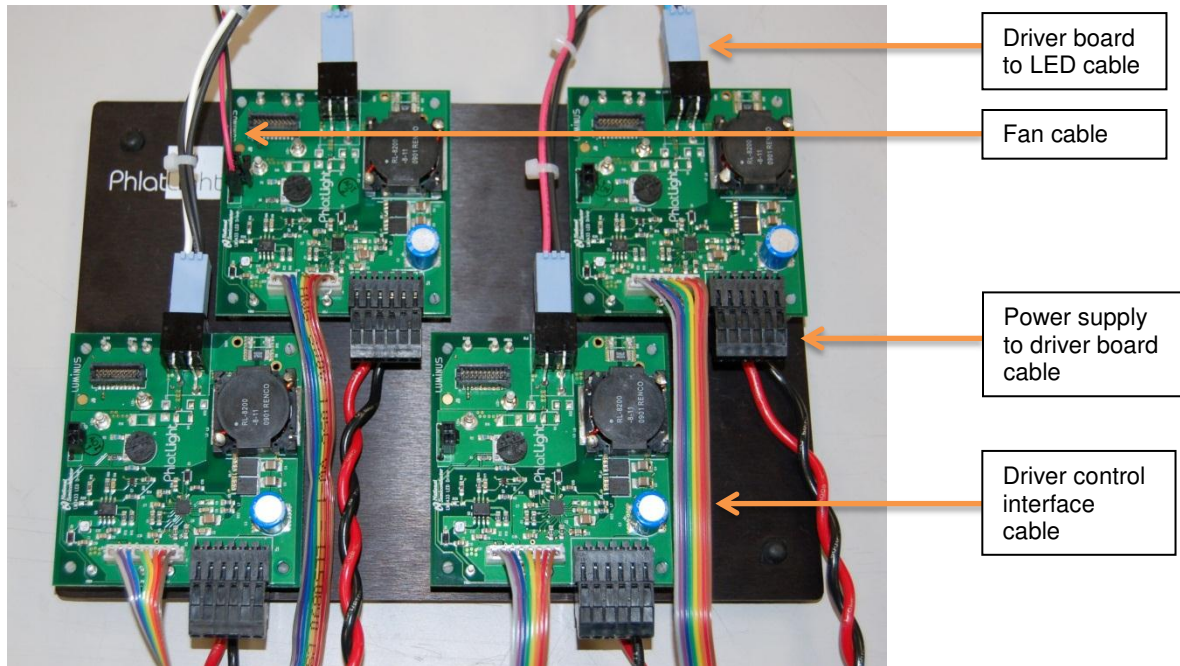


Figure 10: Completed electrical connections on DK-414N-4

4. Operating Instructions

The DK-414N-4 Development Kit can be used to drive LEDs in continuous-current controlled mode via the on-board POT or through an external analog voltage. Additionally, each channel has inputs for PWM dimming using an external function generator and supports frequencies up to 40 kHz.

1. Current control via the on-board POT is achieved by shorting the Analog ADJ and POT pins. Clockwise rotation of the POT increases the current, while counter-clockwise rotation decreases the current.

CAUTION: The driver board is capable of providing 14 A to any color. Each color has different drive current limitations and care must be taken not to exceed these limitations. Consult product data sheets for current and junction temperature limitations of specific colors. Do not set all drivers at maximum current output! Doing so will damage the LED module.

2. To determine the current through the LED, measure the voltage across the sense resistor test studs placed to the left and right of “R9” (see Figure 1). Figure 11 shows the relationship between the sense resistor voltage (V_{sense}) and the LED current, I_{LED} , which is also calculated using:

$$I_{LED} = \frac{V_{Sense}}{R_{Sense}} \quad (1)$$

where the sense resistance, $R_{Sense} = 0.005 \Omega$.

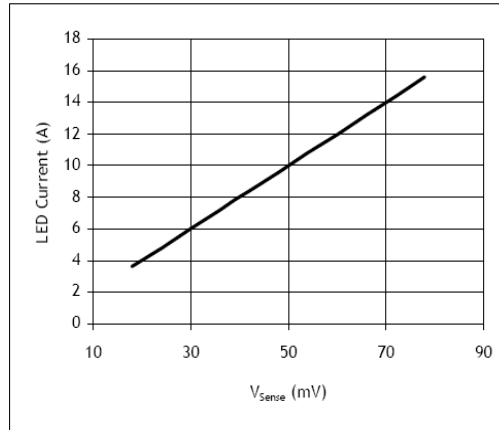


Figure 11: LED Current as a function of V_{sense}

- To control the current externally, connect the positive of a 0-5 V signal to the Analog ADJ pin and the negative to the GND pin, using the signal cable. Figure 12 shows the relationship between the LED current and the external voltage.

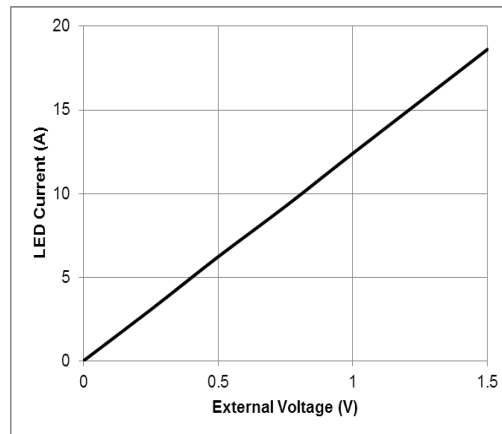


Figure 12: LED Current vs. External voltage

- To modulate the LEDs through PWM, connect the 0-5 V pulsed output of a waveform generator across the PWM and GND pins on the signal cable, with the PWM pin at a positive voltage with respect to GND. The Analog ADJ and POT pins should be shorted to control the LED current via the on-board POT. Proper operation is best monitored by using a photo detector to observe the light output from the LED. Note: Exceeding 5 V on the PWM pin may cause permanent damage to the driver board.
- Coreboard temperature (T_{ref}) of the CBM-380 is monitored using a Murata Manufacturing Co. thermistor (part number NCP15XH103J03RC). Thermistor test points THRM1 and THRM2, if connected to the LED by the driver board to LED cable, can be used to determine the coreboard temperature. Signal Pins 7 and 8 are also thermistor test points and are equivalent to THRM2 and THRM1. Figure 13 shows the relationship between the temperature of the coreboard and the resistance between the thermistor test points. Note that there is a temperature rise from T_{ref} to the LED junction; for guidance on estimating the LED junction temperature (T_j), refer to the CBM-380 product datasheet.

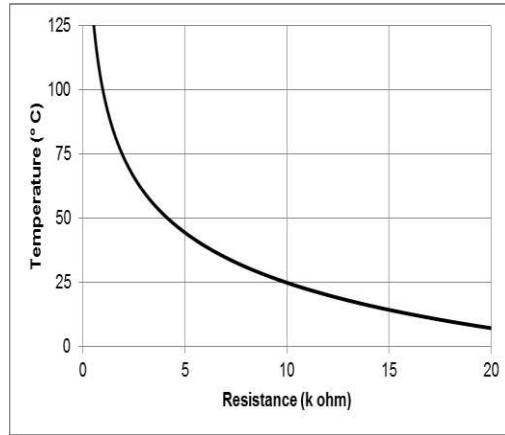


Figure 13: Coreboard temperature as a function of thermistor temperature

Appendix A: Development Kit contents

| Part Number | Qty | Description |
|-------------|-----|--|
| 960003 | 1 | HEATSINK |
| 960008 | 4 | DRIVER BOARD |
| 960022 | 4 | POWER SUPPLY TO DRIVER BOARD CABLE |
| 960023 | 4 | SIGNAL CABLE |
| 960024 | 1 | DRIVER BOARD TO LED CABLE (WITH FAN CABLE) |
| 960031 | 1 | MANUAL |
| 960010 | 2 | THERMAL INTERFACE MATERIAL |

Table 2: List of contents

Appendix B: Electrical Design Considerations

The CBM-380 LEDs are built with a common anode configuration i.e., the copper core-board is at a positive electrical potential with respect the LED cathode. The DK-414N-4 development kit addresses this by configuring the LED in a grounded common anode topology, i.e., the anode is kept at ground and the cathode is at a negative potential. The LED anode can be in direct electrical contact with the heat sink without concern for electrical contact with other LEDs. A basic schematic is shown below in Figure 14. It is important to note that while the heat sink is at ground, there is still power passing through it.

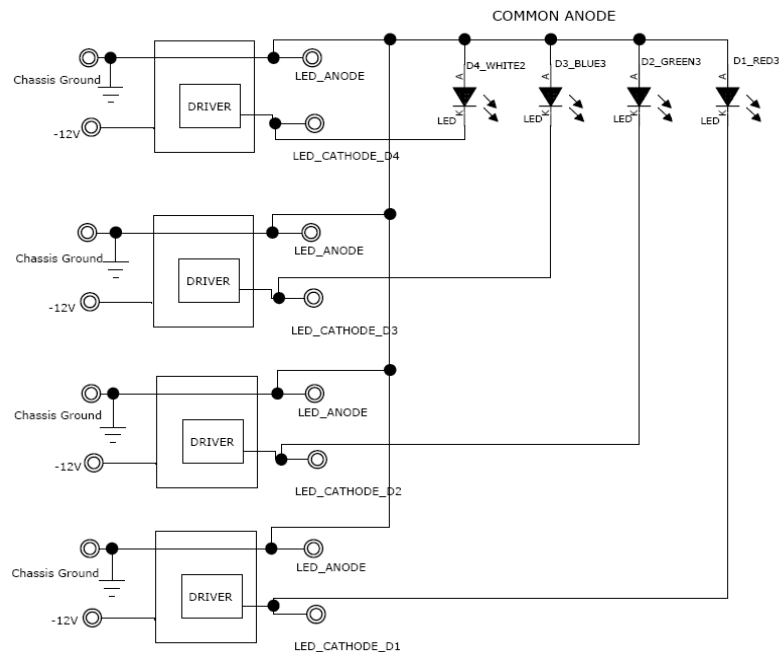


Figure 14: Grounded common anode topology

Appendix C: Isolated AC-DC Power Supplies

Table 3 lists a few isolated AC-DC power supplies. A power supply with isolated outputs is required to properly drive the DK-414N-4 and failure to use an isolated power supply may damage the driver board. For best efficiency, select a power supply that closely matches the required power.

| Power | Manufacturer | Input | Output V/I | Size | Mounting | Part # |
|-------|--------------------------|-----------------------------|-------------|--------------------------|---------------------------|---------------------|
| 30W | CUI Inc. | AC 85-264 VAC (47-400Hz) | 12V / 2.5A | 3.7" x 2" x 0.85" | Thru-hole/SMT | FSK-S30-12U |
| 50W | Omron | AC 85-264VAC (47-63Hz) | 12V / 4.2A | 5" x 3.34" x 1.57" | DIN Rail | S8SP-05005 |
| 50W | Lambda Power | AC 90-264VAC (47-63Hz) | 12V / 3A | 3.62" x 1.46" x 6.26" | Enclosed/Chassis mount | SWS Series |
| 60W | Globtek Inc. | AC 90-264VAC (47-440Hz) | 12V / 5A | 5.24" x 2.39" x 1.62" | External/Desktop | DPS50 |
| 75W | Lambda Power | C 90-264VAC (47-63Hz) | 12V / 6.3A | 3.7" x 1.69" x 6.69" | Enclosed/Chassis mount | SWS Series |
| 100W | Lambda Power | AC 90-264VAC (47-63Hz) | 12V / 8.5A | 3.78" x 1.77" x 7.4" | Enclosed/Chassis mount | SWS Series |
| 100W | Elpac Power | AC 100-264VAC (47-63Hz) | 12V / 8.3 | 7.36" x 4.33" x 2.32" | External/Desktop | FWP10012- D8F-NC |
| 125W | Power-One So- lutions | AC 90-264VAC (47-63Hz) | 12V / 10.5A | 5" x 3" x 1.25" | Open Frame | MBP125-1012 |
| 120W | AULT Inc. | AC 100-264VAC (47-63Hz) | 12V / 10A | 9" x 2.9" x 2" | Medical/External | MW122RA12X XF01 |
| 150W | Lambda Power | AC 90-264VAC (47-63Hz) | 12V / 12.5A | 3.9" x 2" X 7.8" | Enclosed/Chassis mount | SWS Series |

Table 3: List of AC/DC power supplies with an isolated output

Appendix D: Driver Specification

| Input Specifications | Value | Unit | Note |
|--------------------------------|-------|------|--------------------|
| Input Voltage | 12 | V | |
| Max Supply current/channel | 7 | A | |
| Efficiency | >90 | % | |
| Output Specifications | Value | Unit | Note |
| Max output current | 17 | A | |
| Output current ripple (pulsed) | <10 | % | Of set current |
| Output Pulse Rise time | <1 | us | |
| Output Pulse Fall Time | <1 | us | |
| Output Setting Time | <5 | us | min current to max |
| Control Specifications | Value | Unit | Note |
| Max Pulse Frequency | >40 | kHz | |
| Duty Cycle Range | 0-100 | % | |

Table 4: Driver board Specifications

Appendix E: Driver Board Schematic and Pin-out

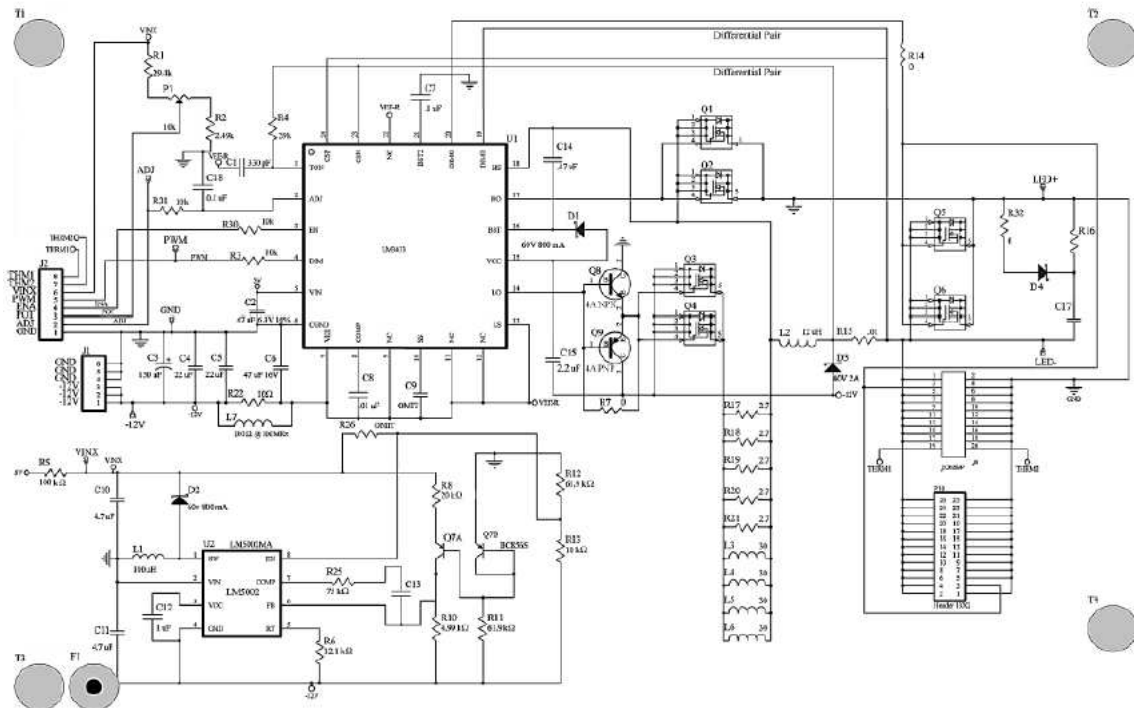


Figure 15: Driver board schematic and pin-out

Appendix F: LED and Driver Board Pin-out

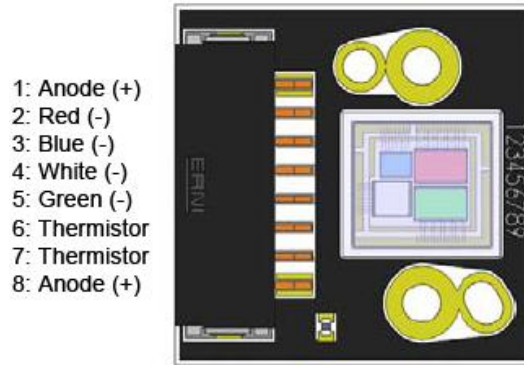


Figure 16: CBM-380 pin-out

| Pin | Description |
|-------|-------------|
| Pin 1 | GND |
| Pin 2 | Analog ADJ |
| Pin 3 | POT |
| Pin 4 | Enable |
| Pin 5 | PWM |
| Pin 6 | Vinx |
| Pin 7 | Thermistor |
| Pin 8 | Thermistor |

Table 5: Signal pin-out

| Driver board Pin | Description |
|------------------|-------------|
| Pin 1 | -12 V |
| Pin 2 | -12 V |
| Pin 3 | -12 V |
| Pin 4 | GND |
| Pin 5 | GND |
| Pin 6 | GND |

Table 6: Driver Board, Power

| Fan Pin | Description |
|---------|-------------|
| Pin 1 | -12 V |
| Pin 2 | GND |

Table 7: Fan pin-out

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