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Procuring Parts for Algal Shaker

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ABSTRACT

This page describes in detail the procurement of parts required for building the orbital shaker. The components can be sourced from four types of suppliers.

- Laboratory equipment suppliers
- Electronics parts distributors
- Printed circuit board manufacturer
- 3D printing service (or in-house 3D printer)

The orbital shaker can be sourced from laboratory equipment suppliers. The orbital shaker described in this protocol was bought on ebay.

All electronics components and mechanical fixings can be bought from electronics parts distributors. In the described case, it was Farnell.

The clear acrylic sheet can be bought from specialist local supplier of sheet plastic or can be ordered laser cut to size and shape by local laser-cut service providers.

The custom-made printed circuit board (PCB) simplifies and speeds up the assembly and results in a smaller, more robust circuit. Here, Seeed Technology was used for their low-cost, high-quality PCBs production service.

The electronics is housed in a custom case. It can be produced on a fused-deposition modelling 3D printer - in-house or outsourced to third-party manufacturers. An in-house Stratasys Uprint SE Plus was used here.

EXTERNAL LINK

https://app.labstep.com/sharelink/ea951899-3e14-4591-91f2-6d5e5aa7bd48

GUIDELINES

This document describes the procurement of parts required to build the illuminated orbital shaker for microalgae culture. It also discusses the workshop tools and stationaries required in the assembly process.

All parts list and tools required to build and assemble the illuminated orbital shaker are in the following spreadsheet:

OrbitalShaker_PartsList.xlsx

1 Obtain the list of parts and tools required to build and assemble the illuminated orbital shaker by downloading the file:

OrbitalShaker_PartsList.xlsx

The content of the above spreadsheet are discussed in the steps below.

2 **Ordering the Orbital Shaker**

It should be possible to convert any orbital shaker by adding the illuminator and a raised clear acrylic platform to hold the algal cultures. Many labs may have spare orbital shakers that can be repurposed in this way. Second-hand ones could be found on online auction sites and spare lab equipment resellers pages. New professional orbital shakers start at around £700 (2019).

It is essential the orbital shaker platform is larger than than 22 cm × 20 cm. Otherwise, the heatsink, fans and stand-offs holding the acrylic platform might not fit.

For this project, we bought a basic orbital shaker imported from China. It can be found on ebay. It retailed for £95.30 in May 2019 - including shipment, import duties and VAT. The protocol will always refer to this particular orbital shaker, which is still on sale on ebay (Nov 2019). The shaker worked continuously during the past 6 month without any glitches. The major drawback of this orbital shaker is the loud noise it produces, compared to high-end orbital shakers, which are barely audible.

The seller image of the KJ-201BD orbital shaker.

Below is a table listing the orbital shaker. It is the only laboratory equipment required for this project. The orbital shaker is also listed in the "Laboratory Parts" tab of the OrbitalShaker_PartsList.xlsx spreadsheet.

Item	Qty	Description	Distributor	Manufacturer	Order Code	Part Number	Unit Price [£]	Total [£]
1	1	Orbital Shaker	eBay		283712826465	KJ-201BD	95.30	95.30
Total								**95.30**

Table of laboratory parts used in the build of the illuminated orbital shaker.

3 Ordering Electronic Parts

Electronic parts for the illuminated orbital shaker can be sourced from various suppliers worldwide. Farnell was chosen for its comprehensive offer, competitive price and fast delivery. Any other suitable supplier could be used instead. Many of the standard components can be substituted for different parts. This includes the 0603-size resistors, the BSS138W transistor, and the pin header, shunt jumper, and the fuse. The capacitors can also be swapped for equivalent kind, bearing in mind that the rated Voltage and dielectrics must not be lower specification than theose listed.

The electronics parts are listed in the table below and in the "Electronics Parts" tab of the OrbitalShaker_PartsList.xlsx spreadsheet:

Item	Qty	Value	Description	Distributor	Manufacturer	Order Code	Part Number	Unit Price [£]	Total [£]
1	3	10u/50V	10µF/50V X5R 1206 ceramic capacitor (pack of 5)	Farnell	Murata	2672214	GRT31CR61H106KE01L	0.525	2.625
2	1	47u/63V	47µF/63V electrolytic capacitor	Farnell	Panasonic	2326166	EEE1JA470UP	0.679	0.679
3	2	100n	100nF/50V X7R 0603 ceramic capacitor (pack of 10)	Farnell	Multicomp	1759122	MC0603B104K500CT	0.0341	0.341
4	1	MAX6006	1.25V shunt reference	Farnell	Maxim Integrated	2511278	MAX6006BEUR+T	1.29	1.29
5	1	LDU2430S1000	24V/1A adjustable LED driver	Farnell	XP Power	1738296	LDU2430S1000	8.23	8.23
6	1	Fuse Holder	5x20mm fuse holder (pack of 10)	Farnell	Schurter	2309093	751.0052	0.103	1.03
7	1	T1.25A	1.25A slow-burning fuse (pack of 10)	Farnell	Eaton Bussmann	1123242	S506-1.25-R	0.836	8.36
8	1	2.1mm DC Jack	2.1mm 2A/16V DC power jack	Farnell	Cliff Electronics	2450496	FC681478	1.84	1.84
9	6	2way Screw Terminal	2way 3.81mm screw terminal	Farnell	Multicomp	2007985	MC000018	0.481	2.886
10	1	3way Shunt Header	3way 2.54mm header (pack of 50)	Farnell	Multicomp	1593412	2211S-03G	0.0156	0.78
11	1	Shunt Jumper	2.54 mm shunt jumper (pack of 50)	Farnell	Multicomp	2834673	MC-2228CG	0.0262	1.31
12	1	BSS138W	50V 200mA N-channel MOSFET (pack of 5)	Farnell	Diodes	1713833	BSS138W-7-F	0.265	1.325
13	3	27k	27kΩ 0603 1% SMD resistor (pack of 10)	Farnell	Multicomp	2447315	MCWR06X2702FTL	0.0038	0.038
14	1	1k0	1kΩ 0603 1% SMD resistor (pack of 10)	Farnell	Multicomp	2447272	MCWR06X1001FTL	0.0038	0.038
15	1	560R/500mW	560Ω 1206 1% 500mW SMD resistor (pack of 10)	Farnell	TE Connectivity	2332136	CRGH1206F560R	0.0447	0.447
16	1	6k8	6.8kΩ 0603 1% SMD resistor (pack of 10)	Farnell	Multicomp	2447427	MCWR06X6801FTL	0.0034	0.034
17	1	2k7	2.7kΩ 0603 1% SMD resistor (pack of 10)	Farnell	Multicomp	2447324	MCWR06X2701FTL	0.0034	0.034
18	3	820R	820Ω 0603 1% SMD resistor (pack of 10)	Farnell	Multicomp	2447437	MCWR06X8200FTL	0.0035	0.035
19	1	390R	390Ω 0603 1% SMD resistor (pack of 10)	Farnell	Multicomp	2447353	MCWR06X3900FTL	0.0037	0.037
20	1	270R	270Ω 0603 1% SMD resistor (pack of 10)	Farnell	Multicomp	2447314	MCWR06X2700FTL	0.0038	0.038
21	1	100R	100Ω 0603 1% SMD resistor (pack of 10)	Farnell	Multicomp	2447227	MCWR06X1000FTL	0.0034	0.034
22	1	220R	220Ω 0603 1% SMD resistor (pack of 10)	Farnell	Multicomp	2447298	MCWR06X2200FTL	0.0034	0.034
23	1	150R	150Ω 0603 1% SMD resistor (pack of 10)	Farnell	Multicomp	2447255	MCWR06X1500FTL	0.0035	0.035
24	1	180R	180Ω 0603 1% SMD resistor (pack of 10)	Farnell	Multicomp	2447267	MCWR06X1800FTL	0.0034	0.034
25	1	47R	47Ω 0603 1% SMD resistor (pack of 10)	Farnell	Multicomp	2694082	MCWF06P47R0FTL	0.0083	0.083
26	2	100R/500mW	100Ω 1206 1% 500mW SMD resistor (pack of 10)	Farnell	TE Connectivity	2332126	CRGH1206F100R	0.0423	0.423
27	1	DPDT Switch	DPDT On-Off-On toggle switch	Farnell	Multicomp	9473556	1MD4T1B1M1QE	2.60	2.60
28	1	6pos Rotary Switch	6-position rotary switch	Farnell	Nidec Copal	2854809	SS-10-16NP-LE	2.48	2.48
29	1	DIP-8 Socket	DIP-8 socket for rotary switch	Farnell	Multicomp	2668408	SPC15494	0.133	1.33
Total									**38.45**

Table of electronics parts used in the build of the illuminated orbital shaker.

Availability of Components in the Bill of Materials

Some of the above components may be already available in local electronics workshops and do not need to be purchased. Items 3, 7, 10-14, and 16-25 are most likely to be broadly available and could save £13 off the bill of materials.

4 Ordering Mechanical Parts and Fixings

There are several different types of mechanical parts and fixings required to build the illuminated orbital shaker. Most of them are common and may well be locally available. The only less usual component is a 50 mm-long M4 standoff. The mechanical parts are listed in the table below and in the "Fixings" tab of the OrbitalShaker_PartsList.xlsx spreadsheet:

Item	Qty	Value	Description	Distributor	Manufacturer	Order Code	Part Number	Unit Price [£]	Total [£]
1	4	M4 Nut	M4 zinc-plated steel nut (pack of 100)	Farnell	TR Fastenings	1419449	M4-HFST-Z100-		1.59
2	8	M4 Washer	M4 zinc-plated steel washer (pack of 100)	Farnell	TR Fastenings	2506009	DM4-FASTWAZ100DIN125		1.14
3	4	M4×12 Screw	M4 12mm zinc-plated pan head screw (pack of 100)	Farnell	TR Fastenings	1419994	M4 12 PRSTMC Z100		2.08
4	4	M3×10 Screw	M3 10mm countersunk zinc-plated screw (pack of 100)	Farnell	TR Fastenings	1420398	M3 10 KRSTMC Z100		1.64
5	4	50mm M4 Standoff	50mm M4 standoff male-female	Farnell	Ettinger	1466738	05.14.501	0.73	2.92
Total									**9.37**

Table of mechanical parts and fixing used in the build of the illuminated orbital shaker.

Note for Imperial Thread Size Users

The table above includes a several M4 and M3 fixings. here imperial thread are used, swap #8-32 UNC thread for M4 and #4-40 UNC thread for M3:

- *4× #8-32 UNC nuts*
- *8× #8-32 UNC washers*
- *4× #8-32 UNC 1/2"-long pan head screws*
- *4× #4-40 UNC 3/8"-long countersunk screws*
- *4× 2-inch #8-32 male-female standoff (1964, Keystone).*

Availability of Components in the Bill of Materials

The washers, screws and nuts are likely to be available in local workshops and not buying them could save £6 off the bill of materials.

5 LED Illuminator Parts

The LED illuminator consists of LED strips attached to a heatsink, cooling fans and wires that connect all components together and the LED controller electronics circuit. The list also includes a wall socket plug-in power supply and a 24-hour time switch to control the daily sequence of the LED illuminator. The components required to build the LED illuminator are listed in the table below and in the "LED Illuminator Parts" tab of the OrbitalShaker_PartsList.xlsx spreadsheet:

Item	Qty	Value	Description	Distributor	Manufacturer	Order Code	Part Number	Unit Price [£]	Total [£]
1	2	1m LED Strip	LED strip, 1m, cool white, 24VDC, 14.4W	Farnell	Ledxon Modular	2214009	9009079	25.84	51.68
2	4	40mm Fan	12 VDC Fan, 60mA, 40mm	Farnell	Multicomp	2816685	MC002106	2.11	8.44
3	1	30V/1A AC Adaptor	30V/1A 2.1mm DC power supply	Farnell	Ideal Power	2771453	15DYS624-300100W-K	23.37	23.37
4	1	LED Heatsink	Heatsink, 200 mm x 150 mm x 40 mm, 0.5 °C/W	Farnell	Fischer Elektronik	4621906	SK 47/150 SA	35.71	35.71
5	2	Black Cable	0.5 mm2 black cable for LED strip connection	Farnell	Pro Power	2528081	PP001185	0.315	0.63
6	2	Red Cable	0.5 mm2 red cable for LED strip connection	Farnell	Pro Power	2528174	PP001269	0.315	0.63
7	1	Clear Acrylic	4 mm clear acrylic sheet (any make, > 30cm×20cm)	RS	RS Pro	824-660	824-660	32.72	32.72
8	1	24H Time Switch	Programmable 24-hour socket time switch (any make)	Farnell	Pro Elec	2777066	PEL00407	2.01	2.01
Total									**155.19**

Table of electrical parts used in the build of the LED illuminator for the orbital shaker.

Note for Non-UK Regions

The power supply and the 24-hour timer (items 3 & 9) are for UK sockets. Other parts of the world have different line Voltage and sockets. Find a 30V/1A power supply with a 2.1mm DC connector and a programmable 24-hour socket timer that are suitable and certified for use in your region.

Note for Non-Metric Regions

Items 6 & 7 are cables with 0.5 mm^2 cross-section. This is roughly equivalent to AWG 21 cables. Choose a suitable cable, which is close to this gauge. Thicker cables can force the LED strips to lift off from the heatsink and thinner gauges may be insufficient to support the current.

Note on the Clear Acrylic Sheet

Here, an off-the-shelf clear acrylic was used. The 4 mm (5/32") thick clear acrylic is ideal. A thinner one might be to weak and a thicker one might be impossible to fix to the stand-offs. However the exact make and size of the sheet are irrelevant.
Polycarbonate could also be used instead of acrylic. It may be easier to drill and cheaper, but absorb more light.

6 ## Checking Local Availability of Tools

To assemble the orbital shaker several tools are required. Hopefully most of these tools will be available in local workshops or office, saving most of the listed costs.

The tools parts list in the table below and in the "Tools" tab of the OrbitalShaker_PartsList.xlsx spreadsheet is divided into five sections:

- Workshop Tools
- Stationaries
- Soldering Equipment
- 3D Printing
- Cutting and Drilling Tools

Item	Qty	Value	Description	Distributor	Manufacturer	Order Code	Part Number	Unit Price [£]	Total [£]
			Workshop Tools						
1	1	M3 Tap Set	M3 thread tap set (any make, #4-40 for imperial threads)	Farnell	Ruko	375238	230-030	8.77	8.77
2	1	Tap Wrench	Tap Wrench (any make)	Farnell	Ruko	376395	241 001	10.71	10.71
3	1	Tool Kit	Mechanical workshop tool kit (any make)	RS	RS Pro	829-6561	829-6561	108.59	108.59
4	1	DMM	General digital multimeter (any make)	RS	RS Pro	123-1930	123-1930	30.00	30.00
			Stationeries						
5	1	Multipurpose Glue	All purpose clear adhesive (any make)	Amazon	Bostik	B0001OZI48	All Purpose	1.58	1.58
6	1	Scissors	Common scissors (any make)	Amazon	Helix	B00XP1V0UU	Oxford 13cm	1.39	1.39
7	1	Pen	Fine tip permanent marker pen (not black, any make)	Amazon	Staedtler	B005DPPQAG	733449	1.66	1.66
8	1	Ruler	Ruler 30 cm (any make)	Amazon	Q Connect	B000NMBTUK	Ruler	0.59	0.59
			Soldering Equipment						
9	1	Tweezers	Watchmakers tweezers (any make)	Farnell	Duratool	3127692	1PK-125T-F	3.22	3.22
10	1	Solder Flux	Solder flux (any make)	Farnell	Chip Quik	1850220	SMD291NL	11.94	11.94
11	1	Solder Wire	Thin solder wire (any make)	Farnell	Duratool	3262209	D03341	5.18	5.18
12	1	Soldering Station	Soldering station suitable for SMD (any make)	Farnell	Metcal	1560738	PS-900	187.00	187.00
13	1	Electrical Tape	PVC Electrical Insulation tape (any make)	Farnell	Pro Power	152346	PVC TAPE 1920B	1.18	1.18
14	1	IPA	Isopropyl alcohol for cleaning (any make)	Amazon	Hexeal	B079YVPZDF	IPA	6.79	6.79
15	1	Small Tub	Margarine tub or something similar						
16	1	Brush	Old toothbrush or stiff paintbrush						
			3D Printing						
17	1	3D Printer	FDM 3D Printer with build material (any make, or outsource)		Stratasys	uPrint SE Plus	uPrint SE Plus		
			Cutting and Drilling Tools (Either tools or laser cutter, both not required)						
18	1	Drill	General hand or pillar drill (any make)	Amazon	Skil	B00IINANZ8	6221AB	44.99	44.99
19	1	4mm Drill Bit	HSS drill bit 4 mm (any make, ideally spur-point bit for plastic)	Farnell	Ruko	378124	201 040	0.44	0.44
20	1	Hacksaw	300 mm hacksaw (any make)	Farnell	Duratool	2103261	D02166	7.32	7.32
21	1	P150 Sandpaper	P80-P180 sandpaper (any make)	Amazon	3M	B001PNBC0I	20150	4.49	4.49
22	1	Laser Cutter	Optional laser cutter for plastics (any make)						
Total									**435.84**

Table of tools and stationaries used during the build of the illuminated orbital shaker.

Note for Imperial Thread Size Users

Replace the 4 mm drill bit (item 18) with a #16 or #18 drill bit.
Use a #4-40 UNC thread tap instead of the M3 thread tap (item 1).

Note Regarding Multipurpose Glue

The listed multi-purpose glue worked well. This particular brand may not be widely available outside of the UK. Choose any trasparent solvent-based multi-purpose glue. It is important it is a glue that retains some flexibility and cures through evaporation of the solvent. Do not use PVA or superglue.

Note Regarding 3D Printing

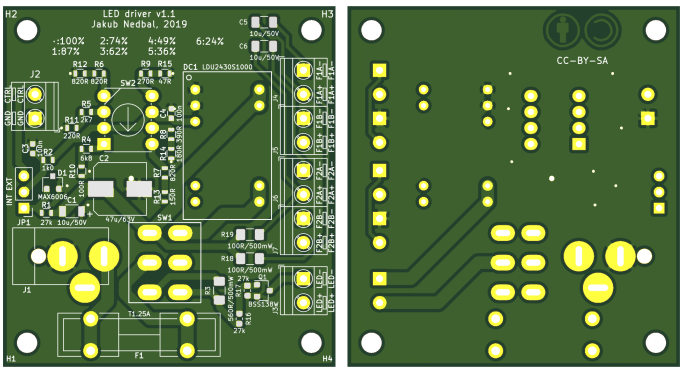
Item 17 is a 3D printer to produce the case for the LED controller electronics. We used a locally available FDM printer. However, other 3D printers should work equally well. Both locally available 3D printers or commercially outsourced 3D printing service can be used. 3D printing by laser sintering would offer a better finish, but this 3D printing technology is less widely available and not required.

Note Cutting and Drilling Tools

Here, mechanical tools (items 18-21) have been used to cut and drill the clear acrylic sheet to build the illuminated shaker platform. However, with laser cutters widely available these days, a better and quicker job could be done by using a laser cutter instead. In that case, the drill, drill bit, hacksaw, and sandpaper will not be required.

7 Ordering the Custom Printed Circuit Board

The printed circuit board (PCB) has been designed specifically for the LED controller circuit. It is a double sided PCB with plated through-holes. All components are mounted to the top side only for ease of assembly. The assembly of the components on the board is described in the document Assembling LED Controller Electronics. The top and bottom view of the PCB are in the picture below:

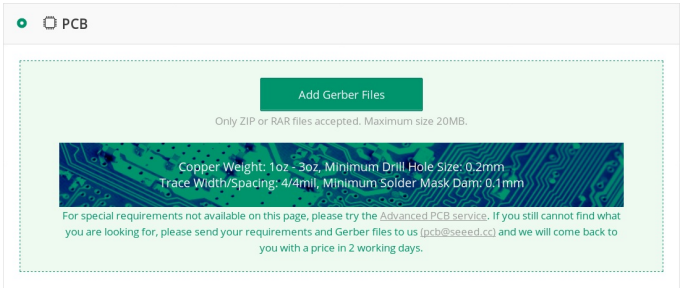


2D rendered image of the top and bottom views of the printed circuit board for the LED controller.

The PCB design has been done in KiCAD, which is a cross platform and open source electronics design automation suite. The source files are available for download from the project GitHub page.

Any PCB manufacturer should be able to produce the PCB from the Gerber files available in the board folder on the project GitHub page. We used Seeed Technology Fusion PCB service to produce the PCB. The ordering process is described below.

- Get the archive LEDregulator.zip
- with Gerber files from the project GitHub page
- Go to the Fusion PCB order page
- Upload the LEDregulator.zip file using the **Add Gerber Files** button:



Snapshot from the Seeed technology website, which is used to upload the Gerber files for PCB production.

- Select the options for the board manufacture. All settings can be left at their default values. Decreasing the order amount to five PCBs does not lower the final price, but could minimize waste and environmental impact.
- Confirm the order, provide shipping and billing details, choose the preferred shipping service and pay the manufacturer.
- Wait a few weeks for the PCBs to arrive.

8 Summary

This document described the procurement of the components for the build of the illuminated orbital shaker for algal cultures. It listed the electronics parts, the tools and fixings required for the assembly, and it explained the process to order the printed circuit boards. The next document explains how the obtained components are used to build a functioning LED regulator:

9 References

- OrbitalShaker_ElectronicsPartsList.xlsx: Excel document listing all electronics and electrical parts, and fixing required in the assembly of the illuminated Orbital Shaker.
- GitHub Project Page: Electronics design files for KiCAD.
- LEDregulator.zip: Gerber files for PCB manufacture.
- Seeed Technology Fusion PCB order page: Website to order the PCB production.
- KiCAD: Cross platform and open source electronics design automation suite.

10 **This document is part of the Illuminated Orbital Shaker for Microalgae Culture project:**

- Procuring Parts for Algal Shaker *(this document)*
- Assembling LED Controller Electronics
- 3D Printing Case for LED Controller
- Assembling Cooled LED Illuminator
- Cutting and Drilling Clear Acrylic Sheet
- Assembling the Algal Shaker