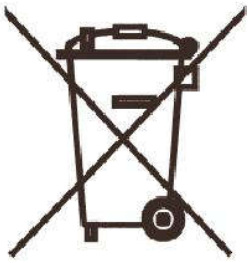
QUASAR KIT # 3193v2 – Smart SLA Battery Charger

General Guidelines for Electronic Kits and Assembled Modules

Thank you for choosing one of our products. Please take some time to carefully read the important information below concerning use of this product. The assembly and operating instructions are on the following pages. Help with component identification can be found on our website at quasarelectronics.co.uk/componentid.htm. If you are unsure about any aspect of the assembly or use of this product please contact our Support Team before proceeding.



WEEE Directive (Waste Electrical and Electronic Equipment)

Notice To All European Union Citizens. Important environmental information about this product.

The crossed out wheeled bin symbol on this product, package or documentation indicates that disposal of this product after its lifecycle could harm the environment. Do not dispose of this product (or batteries if used) as unsorted municipal waste. It should be disposed by a specialized company for recycling.

The unit should be returned to your distributor or to a local recycling service. Please respect the local environmental rules. If in doubt contact your local authorities about waste disposal rules.

Safety: General rules concerning safe use of our Kits or Modules.

To ensure your safety, please observe these safety measures. In no way are these complete. As safety requirements vary, please check with your local authorities, in order to comply with local requirements. If in doubt, seek the help of a qualified person.

Battery or wall-adaptor operated devices are safe devices. They do not require special attention unless mains voltage is connected to an output e.g. a relay.

To ensure electrical safety, and also protection from fire or personal injury, make sure your mains operated equipment complies with these safety hints:

- Use a suitable plastic enclosure. If a metal enclosure is used, make sure it is properly earthed.
- Use a power switch if the device consumes more than 10W. Use a double pole switch for mains operated, transformer-less kits.
- Mount a fuse in series with the mains switch. Use a slow blow (T) 50mA fuse for transformers up to 10W and a 100mA fuse for transformers up to 20W.
- Use a mains input connector, or a robust power cord with a clamp.
- Internal wiring carrying mains voltages must have a minimum cross-sectional area of 0.5mm^2.

If supplied, attach the power rating label near the power cord of the device and fill-out the mains voltage, frequency, power consumption and fuse values.

Troubleshooting and Support

Over 99% of non-working kits are due to poor soldering or other assembly errors. Components damaged due to incorrect assembly or product use account for the majority of other problems. Faulty components are extremely rare and account for only a very tiny fraction of problems. If you require support please send high resolution images of the front and back of the board to support@quasarelectronics.co.uk so that we can offer advice and support.

Disclaimer

Quasar Electronics reserves the right to change product specifications or to discontinue products without notice. Quasar Electronics cannot be held responsible for any loss or damage, direct or indirect, which might occur from the use of a product. Quasar Electronics Kits or Modules are intended for educational and demonstration purposes only. They are not intended for use in commercial applications. If they are used in such applications the purchaser assumes all responsibility for ensuring compliance with all local laws. In addition, they are not suitable for use as or as a part of life support systems, or systems that might create a hazardous situation of any kind.

QUASAR KIT # 3193v2 – Smart SLA Battery Charger

INTRODUCTION

3193 is a Smart Sealed Lead Acid (SLA) 12V Battery Charger with Current Limiting. The charger uses a two step process for charging SLA batteries – a current limited 'fast' mode followed by a constant voltage 'float' mode.

MAXIMUM CHARGING CURRENT - 1 AMP!

The new v2 board has an onboard 2 Amp safety fuse.

The LED indicates when the charger is in 'fast' mode. When the LED goes out the battery is charged and the charger has switched to 'float' mode.

BEWARE - THE HEATSINK GETS VERY HOT!

The charger should be well ventilated, especially if mounted in a box. If worried about the heat then mount the regulator offboard on a larger heatsink.

The current limiting resistors, regulator and heatsink will get hot when charging a flat battery. At a 1A charging current the regulator will dissipate around 3 Watts. ***The heatsink will be too hot to touch*!**

However the charger has been tested in this condition for hours at a time without any problem.

OBSERVE BATTERY CONNECTION POLARITY TO AVOID DAMAGE!

BACKGROUND INFORMATION

The best way to charge a Sealed Lead Acid (SLA) battery is with a current limited voltage regulator, allowing fast charging while limiting heat buildup and gassing.

SLA batteries are made up of 2V (nominal) cells. Therefore a 12V battery has 6 cells. The following parameters were used for this charger:

1. The charging current should be approximately 0.1 times the battery capacity. So, a 10Ah battery should be charged with a 1A current (10 x 0.1 = 1). This helps to ensure battery life.
2. The charging voltage is 2.45V per cell = 14.7V
3. Float charging voltage is 2.275V per cell = 13.65V

HOW IT WORKS

This two step battery charger works as follows:

Step 1. Charging starts at the maximum current limit. The battery terminal voltage will gradually increase until it reaches the regulator set voltage.

Step 2. As the battery becomes fully charged the current will start to decrease. When the charging current drops to around 140mA (see later) the regulator voltage is decreased to a safe float voltage at which the battery can be left on indefinitely.

CIRCUIT DESCRIPTION

The charger is based around an LM317 (IC1) adjustable voltage regulator. Resistors R2 and R4 and trimpot P1 are used to set the charging voltage.

When setting the output voltage it is important to remove IC2 (LM393) from the circuit. The IC causes the charger to switch to float mode when the battery is fully charged (more on that later).

How does the LM317 set the output voltage?

The LM317 has a fixed voltage of 1.25V across its OUT and ADJ pins. This fixed voltage is applied across fixed resistor R2, giving a constant current of ~10.4mA (1.25/120).

Ignore transistor Q1 for the moment. The current flows through resistor R4 and trimpot P1. This causes a voltage drop across them ranging from 12.5 to 17.7 volts (depending on the value of P1). Add this to the 1.25 volts across the regulator and you get an output voltage in the range of 13.75 - 18.95 volts.

The battery voltage will be 0.7V less than this due to the drop across output diode D3, giving a battery charging voltage range of approximately 13.0 - 18.25 volts.

How does the current limit work?

The current limit is set by resistors R10A and R10B. The value of these resistors is calculated by

R = 0.6V/Imax

where **0.6V** is the transistor turn on voltage (nominal) **R** is the parallel combination of R10A & R10B **Imax** is the charging current limit.

For a 1A current R = 0.6 ohms (0.6V/1A) which means each resistor will be 1.2 ohms (1.2//1.2 = 0.6 ohms).

The voltage across these resistors is used to turn on transistor Q1. The transistor will be turned on when the voltage reaches 0.6 volts (nominally). When the transistor turns on it lowers the voltage at the ADJ pin of the regulator and therefore the output voltage will drop. As the output voltage drops so will the current and the circuit will 'stabilize' to maintain the current limit.

What is the purpose of IC2?

IC2 is an LM393 – Dual Voltage Comparator. One comparator, IC2:A, is used to set the float voltage while the other half, IC2:B, is used to drive the charge indicator LED.

A voltage comparator compares an unknown input voltage to a set reference voltage. In this case the reference voltage is set by resistors R6 and R7. This reference voltage is varying as the regulator output voltage changes. However, once the battery is charging at less than the current limit the output voltage will be fixed so the reference voltage will also be fixed.

The unknown voltage is the voltage across the current limit resistors (R10A & R10B). This voltage is feed into the comparator via resistor R8.

For a battery charging voltage of 14.7V the regulator output will be 15.4V (14.7 + 0.7 across D3). Using the voltage divider rule the reference voltage at pins 2 & 5 of IC2 will be ~85mV.

While the voltage across the current limit resistors is more than 85mV the output of IC2:A will be high (pin3 > pin 2) and R5/P2 will have no effect on the regulator output.

The current required to cause an 85mV drop across the current limiting resistors is ~142mA. This means the battery is fully charged. Comparator IC2:A will switch and its output will go low. This puts resistor R5 and trimpot P2 in parallel with R4 and P1, dropping the total resistance and

therefore the regulator output voltage, which will be around 14.35 volts. Allowing for the 0.7V drop across D3 the battery float charging voltage will be 13.65 volts.

While the battery is charging the LED will be ON. When the charger switches to float mode the LED will go out.

ASSEMBLY

NOTE: 1.2 ohm resistors have been supplied for the current limit resistors R10A and R10B. These will set the charging current limit to 1A (**maximum**). If you require a different current limit then you need to work out the new values for these resistors and supply them yourself.

The following website provides a useful online calculator for working out parallel resistance.
sengpielaudio.com/calculator-paralresist.htm

First check and identify all the components against the parts list. Follow the overlay on the PCB (or below) when inserting components. Start with the lowest height components first – resistors, diodes, IC socket, etc.. Leave the heatsink and regulator IC until last. Make sure that the polarised components, diodes and electrolytic capacitors, are inserted the correct way round. Fit the trimpots, screw terminal blocks and 1000uF capacitor.

Lightly secure the regulator IC to the heatsink using the screw and nut provided. Use some heatsink compound if available. Fit the whole assembly to the PCB and solder into position. Tighten the screw and nut.

Do not insert the IC into the socket – this will be done after setting the output voltage (see below).

POWER SUPPLY SPECIFICATION

The minimum DC input voltage is set by the charging voltage (14.7) plus 3V regulator voltage drop plus the voltage drop (0.7) across the input and output diodes. This works out at 19.1V (14.7 + 3.0 + 0.7 + 0.7).

A 19VDC supply with a current rating of at least 2A should work fine. This is a common power supply used with many laptop/notebook computers and will be readily available from your local computer store or computer swap meet.

SETTING THE OUTPUT VOLTAGE

Setting the output voltage is done with IC2 **not** inserted.

Connect a voltmeter to the battery charging terminals. Adjust trimpot P1 until the voltage reads 14.7 volts.

Disconnect power and insert the IC into its socket. The notch end should be towards the heatsink. Make sure none of IC leads are bent up underneath the IC body when inserting into the socket (a common problem). Connect power again and adjust trimpot P2 until the voltage reads 13.65 volts.

The charger is now ready for use!

CONTACT DETAILS

You can contact tour support team by email at: support@quasarelectronics.co.uk

PARTS LIST – 3193

Resistors (0.25W, 5%, carbon)

1R2 (**metal film**)	R10A,B	2
120	R2	1
1K	R1,7	2
1K2	R3,4	2
1K5	R9	1
12K	R5	1
15K	R8	1
180K	R6	1
Trimpot, 500R 10-turn	P1	1
Trimpot, 5K 10-turn	P2	1

Capacitors

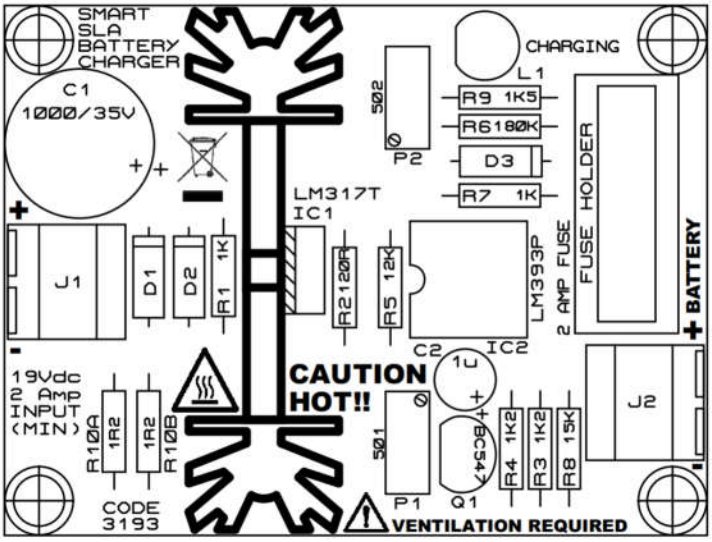
1uF 25V electro	C2	1
1000uF 35V electro	C1	1

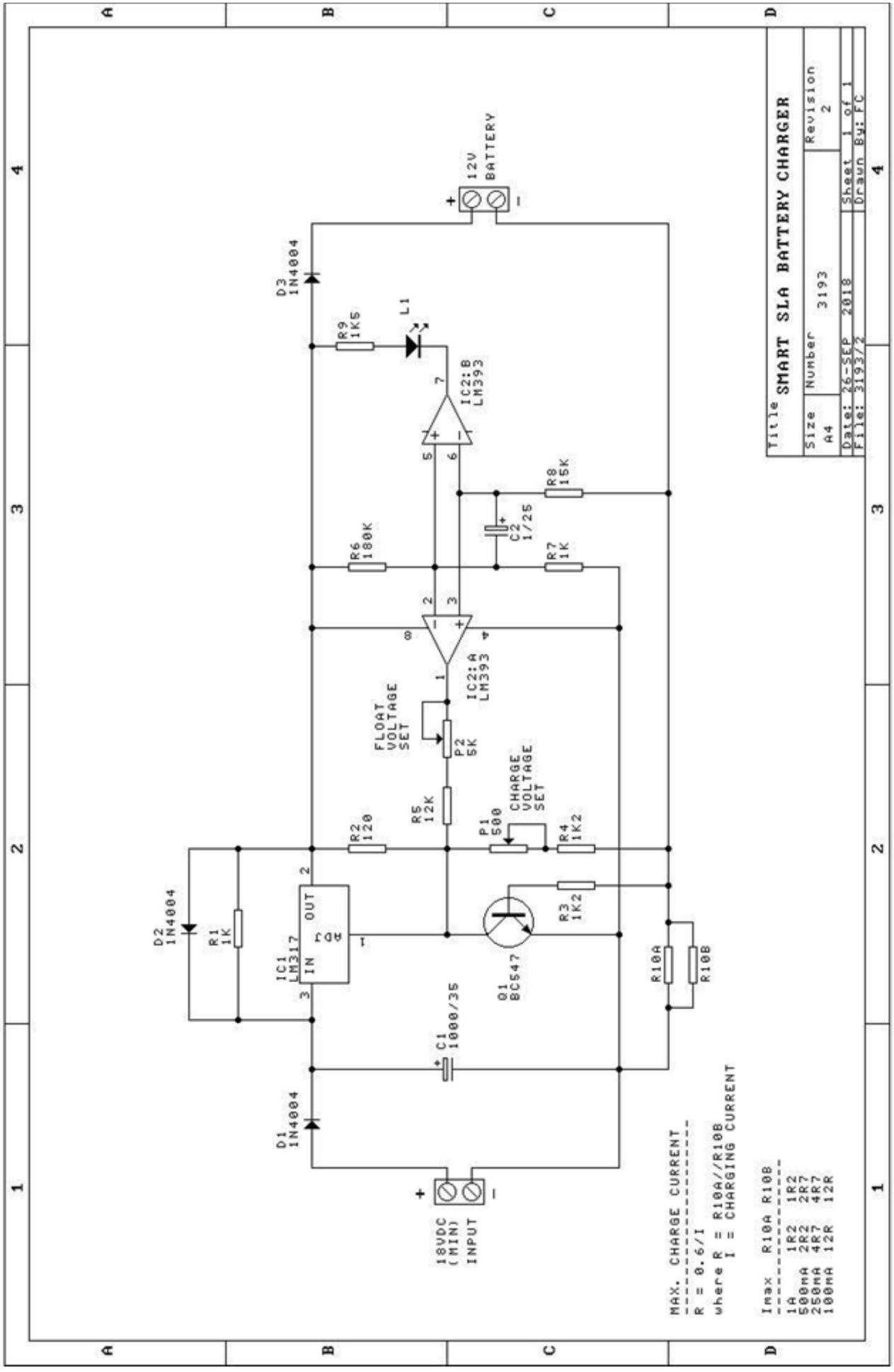
Semiconductors

1N4004	D1-3	3
LM317T	IC1	1
LM393	IC2	1
BC547	Q1	1
LED, 5mm red	L1	1

Miscellaneous

IC socket, 8-pin	for IC2	1
2-Way terminal block	J1,2	2
Heatsink		1
Fuse Holder – 5 x 20mm		1
2A Fuse – 5 x 20mm		1
Screw, 3 x 8mm		1
Nut, 3mm		1
PCB, 3193v2		1




Title SMART SLA BATTERY CHARGER
Size A4
Number 3193
Revision 2
Date: 26-SEP 2018
File: 3193/2
Sheet 1 of 1
Drawn By: FC
12V BATTERY
D3 1N4004
R9 1K5
L1
IC2:B LM393
R8 15K
C2 1/25
R6 180K
R7 1K
IC2:A LM393
FLOAT VOLTAGE SET
P2 5K
R5 12K
P1 500
CHARGE VOLTAGE SET
R4 1K2
R2 120
R3 1K2
D2 1N4004
R1 1K
IC1 LM317
IN OUT ADJ
Q1 BC547
R10A
R10B
C1 1000/35
D1 1N4004
18VDC (MIN) INPUT
MAX. CHARGE CURRENT
R = 0.6/I
where R = R10A//R10B
I = CHARGING CURRENT
Imax R10A R10B
1A 1R2 1R2
500mA 2R2 2R7
250mA 4R7 4R7
100mA 12R 12R