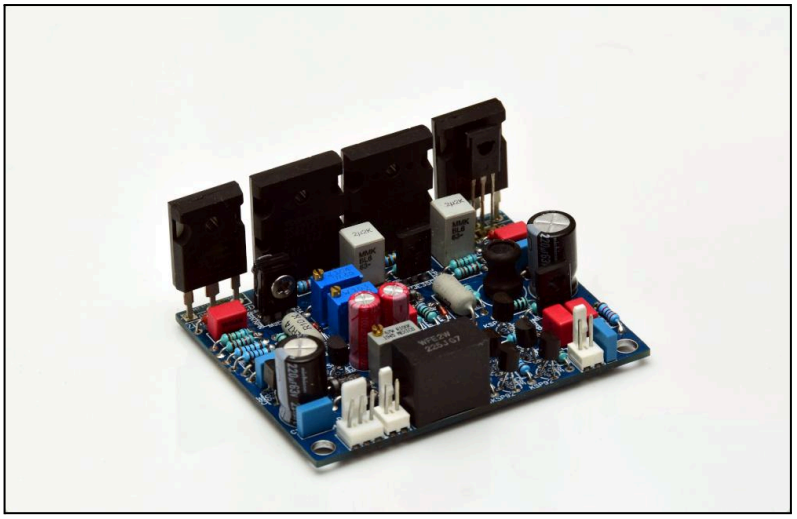
ZinAmp
Beautiful sound, for people who love music

**Datasheet**

Simultaneous Class A Power Amplifier

**Application & Purpose:**
An exceptionally high-quality single-channel power-amp module, for driving passive speaker loads of between 4Ω and 10Ω. A Class A stage drives a more powerful Class B stage, removing crossover distortion and providing Class A sound with Class B power. THD < 0.008% - mostly lower 2nd harmonic

*WARNING: High DC voltage device. Care must be taken to avoid fatal electric shock.*



**Specification:**

| | |
|---|---|
| **PCB Dimensions** | 77mm x 61mm x 1.6mm |
| **Channels** | One |
| **Gain** | 27dB |
| **Input Impedance** | 22kΩ |
| **Frequency Response** | 15Hz-35kHz |
| **Output Devices** | Class A - BJT in push-pull<br>Class B - BJTs as a sziklai pair in push-pull |
| **Output Impedance** | < 0.1Ω |
| **Damping Factor** | ≈100 |
| **Supply Voltage** | +48/-48v DC (regulated power supply module available) |
| **Idle Supply Current** | Class B: 30-50mA<br>Class A: 200mA |
| **Transformer** | 40v +/- AC 220-300VA |
| **Output Power** | 100W into 8ohms, 150W into 4ohms |
| **Earth Nets** | Power and Audio (separated by loop breaker) |
| **THD** | Typically 0.008% at 500Hz - mostly lower 2nd order |

**NOTE:** Since Version 10.8, we have added current-limiting to this amplifier. This protects the output devices from breakdown in the event of a sudden short circuit at the output, although the rail fuses will still blow if this happens. Always use 2A fast-blow rail fuses; one on each DC rail (+ and -) between the power supply and amplifier.

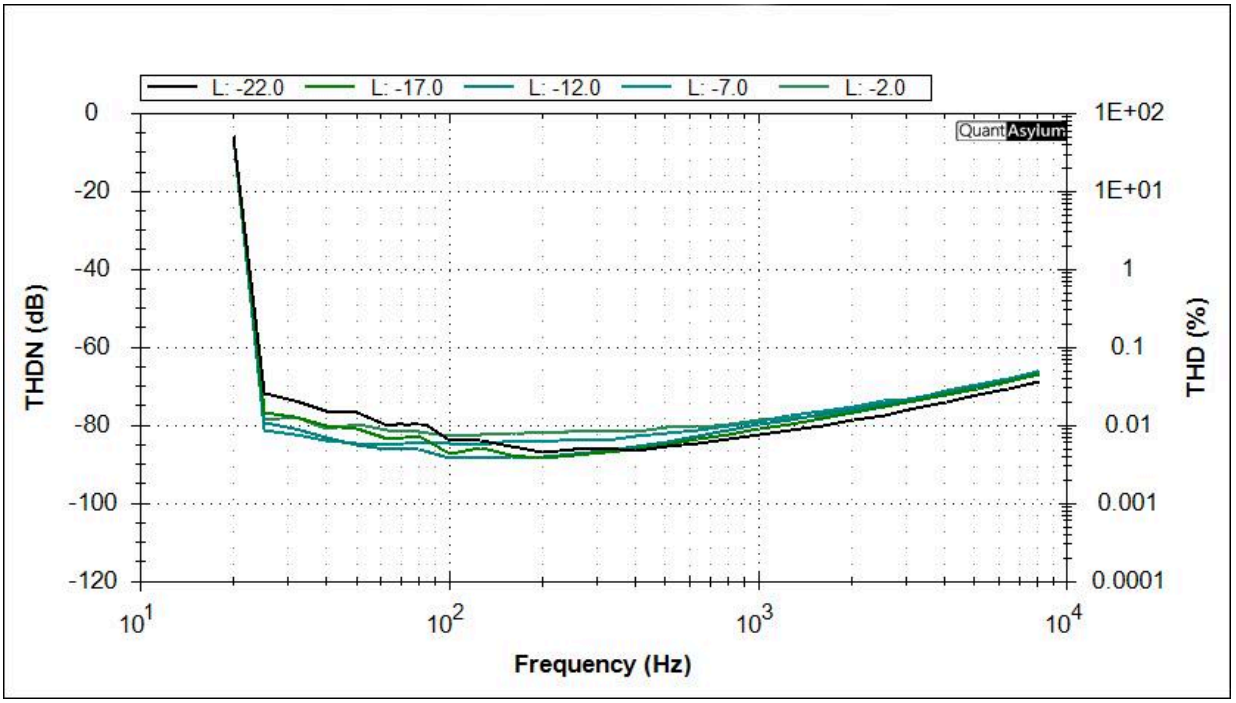
**** We cannot offer help or support if rail fuses are not used - sorry! ****

**Details:**

An exceptionally high-quality audio power amplifier featuring a high-power class B output driven by a push-pull class A stage, both simultaneously driving the output. The Class-A stage eliminates the crossover distortion generated by speaker back-EMF that can otherwise degrade the sound of a Class B amplifier - much like the coveted Quad 405 amplifier. This amplifier differs from the Quad 405 in that the Class A stage has much more power than the 405 and the Class B stage is biased to around 30mA. For these reasons, we believe the performance of this amplifier to be superior to the Quad 405.

An intrinsically stable, low-distortion design, it features a differential input stage with a linear current source, current mirror and bootstrapped voltage amplification stage (VAS). THD and damping factor benefit from global negative feedback and stability is bolstered by a frequency-dependent nested local feedback loop between the amplifier's output and the input to the VAS.

This does not sound like a typical solid-state power amplifier.




**THD across the audio band at different amplitudes. Plot shows THD is lowest (0.006%) in the most audible part of the spectrum (200-500Hz) and only increases slightly with volume:**

**Power Supply:**

**Regulated**: We generally recommend our own regulated power supply for this module as it sustains rail voltages at high power, which in turn maintains distortion performance at high output levels. This power supply can be run at -/+42vDC or -/+48vDC, selectable with jumper switches. 42vDC requires a 2x35vAC toroidal and 48vDC requires a 2x40v toroidal; both in the region of 200-300VA. Larger transformers than this are unnecessary.

**Unregulated**: You may also choose to use our unregulated supply, which is based on conventional filter capacitors, or you can build your own. We recommend 2x6800uF filter caps per rail - four in total. A 2x30vAC toroidal will give approx 42vDC and a 2x35vAC toroidal will give approx 49vDC; 200-300VA is recommended. Don't go beyond this voltage! Higher rail voltages will result in an amplifier that is very hard to bias and overheats very easily; even with large heatsinks.

**Setup and Usage:**

The output devices generate some latent heat and require a reasonable heatsink with a thermal resistance of around 0.45K/W. The heatsinks supplied with your ZinAmp amplifier are sufficient for this. Running this module with no heatsink will result in device failure within a few minutes. Secure to the heatsink and isolate the backs of the output devices from the metal wall of the chassis with silicon or mica isolation pads. Isolation pads are critical - do not expose the metal backs of the output devices to the metal chassis as a short circuit will result.

The Class A stage bias is about 150mA. This is set with a trimmer pot whilst observing the voltage across two small 1Ω resistors on the PCB. The optimum voltage is around 150 millivolts. This rises and falls slightly due to the thermal bias compensation built into the module.

The Class B stage bias is lower - between 40 and 60mA. This is set with a trimmer pot whilst observing the voltage across two large 0.1Ω resistors on the PCB. The optimum voltage is between 4 and 6 millivolts. This rises and falls slightly due to the thermal bias compensation built into the module.

**Grounding to avoid Hum:**

This PCB has two separate ground nets; Power Ground and Audio Ground. Power Ground is marked as HUB on the POWER terminal. Hub refers to a star-ground or earth-hub and ZinAmp makes an Earth Hub PCB for this purpose.

Audio Ground is marked as GND on the IN terminal. This is the ground connection from your RCA input jack socket. This will also need to be connected to the star-ground or earth-hub but with a separate piece of wire. Linking these two grounds together and grounding them with a single piece of wire will cause hum.

For IN, use two-core screened instrument cable. Connect one core to the IN pin and the other to the GND pin. The cable screen must be grounded to the star-ground or hub.

**TOP TIP:** Don't connect power and audio earth terminals/nets together with a single piece of wire or hum will be audible. Grounding an amplifier without introducing hum is a delicate art! These ground nets must only meet/terminate at the star-earth or earth-hub.

**Bridge Mode:**

Older versions of this module used to have a connection for running them in bridge mode. We took this out as many constructors connected their speakers to this thinking it was the loudspeaker ground terminal - which was understandable. The module can still be run in bridge mode, but you do so at your own risk. Running amplifiers in bridge mode is not officially supported and the constructor is fully responsible for any damage to their amplifier or loudspeakers, but as we don't want to ruin anyone's fun, here is a link to an article explaining how to do this: https://sound-au.com/project20.htm

Email us if you have any questions about bridging - we'll help, but the constructor is responsible for the success or failure.

**Safety Note:**

This module runs with DC voltages that are close to 100v DC between negative to positive rails. This is enough to give you a very unpleasant and potentially fatal shock. Unlike AC current, DC is more dangerous when touched as you will tend to stick to it rather than be repelled from it, as with AC. Before handling this module, switch off, disconnect the AC power lead and discharge the power amp power supply in your amplifier by placing a screwdriver across its discharge terminals for 10 seconds. Check the voltage with a meter - if less than 2v, this module is safe to handle.

**Biasing and Heat Management:**

For the recommended 0.45K/W heatsink the following bias setting should be sufficient and will result in a heatsink temperature of around 20-25 degs C above ambient/room temp:

Class A and Class B bias is adjusted using two trimmer pots (VR2 and VR5) - see PCB layout below a few page Bias is set by measuring the voltage across a pair of resistors, as follows:

- Class A, measure voltage across R17 or R21 - target: 150-200mV
- Class B, measure voltage across R34 or R36 - target: 3-5mV

The bias trimmers work like water taps - clockwise to decrease, anti-clockwise to increase.

Setting the bias when the amplifier is cold is impractical because the thermal regulation increases the bias at start up and decreases it as the amplifier warms. Check the bias voltages after switch-on and monitor them for 5 or 10 minutes.

**WARNING**: increasing the Class A bias will also increase the Class B bias. Adjust the Class A bias first with the Class B bias at minimum, then bring up the Class B bias.

Take your time with the Class A bias and make small adjustments. The first few turns may not result in any bias voltage across R17 or R21. As soon as you see a few mV on the meter, SLOW-DOWN. One very-large bias adjustment may be enough to overheat your amplifier within a few seconds!

Check the Bias after 30 mins of running; if it's increased or the amplifier feels hot, turn it down!

**Rail Fuses - IMPORTANT:**

You must run this module with DC rail fuses; one fuse for each DC rail (+ve and -ve). These need to be 2A fast-blow. They sit between the power supply output and the amplifier. Two amplifiers can share the same pair of rail fuses. Unfused installations are not eligible for technical support. If you run your amplifiers without rail fuses and damage occurs, there really is nothing we can do for you!! If you have questions about this, email: help@zinamp.co.uk

Do not rely on the fuse in your mains plug; it won't blow quickly enough and may not blow before your amplifier modules do.

**Instability and Oscillation:**

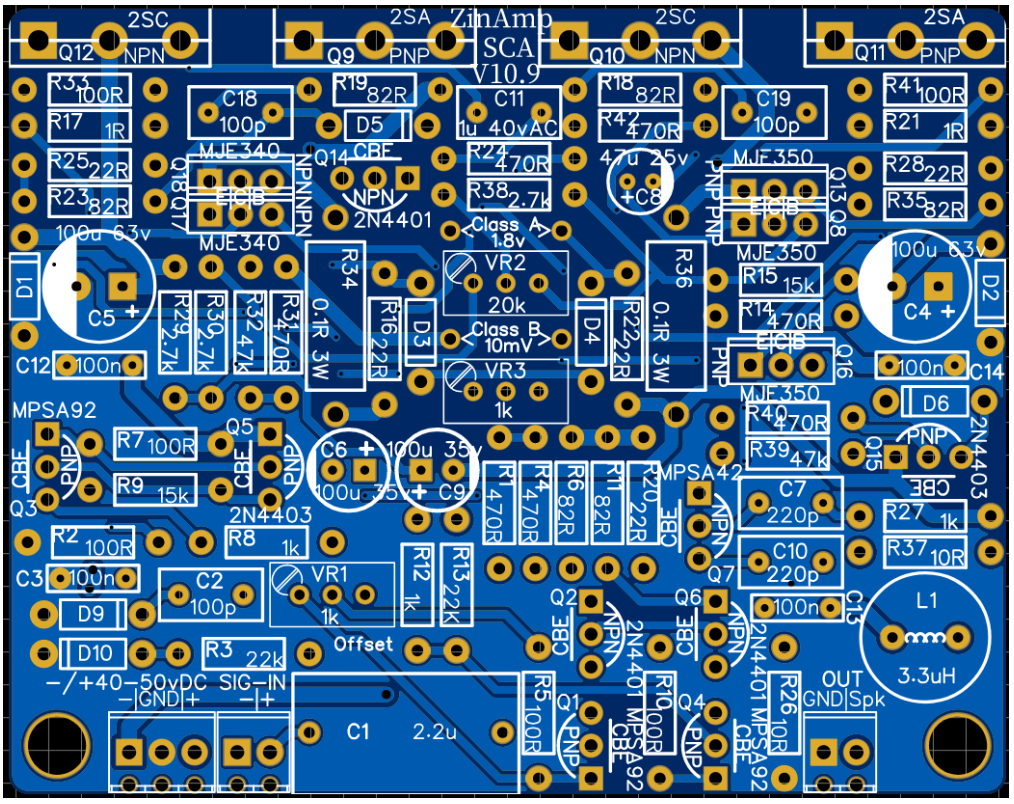
This amplifier is designed to be intrinsically stable and we do not envisage it breaking into oscillation. In the unlikely event of this happening, a resistor marked R26 on the PCB layout below may show evidence of smoke or blackening. This is a tell-tale sign that oscillation has occurred. If you assembled the amplifier yourself and this happens, switch off, remove the power cord, discharge the power supply and remove the amplifier module to inspect it. You will need to remove and replace R26 before proceeding to retest.

**Heat Sink:**

Do not attempt to run this amplifier without firmly attaching it to the heatsink - it will overheat and fail within 30 seconds. Transistors Q14 and Q8 are the thermal regulation devices. These must be aligned and in contact with Q9 and Q11 respectively and firmly screwed to the heatsink. Your amplifier will overheat and fail if you do not do this.

The amplifier is attached to the heatsink using 4 x M3 threaded machine screws. You can make your own mounting plate or they can be purchased from ZinAmp here: [http://www.zinamp.co.uk/modules/wiring.html#PowerAmpMountingPlate](http://www.zinamp.co.uk/modules/wiring.html#PowerAmpMountingPlate)

**Bare PCB:**




**Current Limiting:**

We have recently added current limiting to this amplifier. This will protect the output devices in the event of a short at the output. We still recommend rail fuses. Each DC supply rail (+ve and -ve) must have its own 2.5A fast-blow fuse. Amplifiers not run this way are not eligible for technical support.

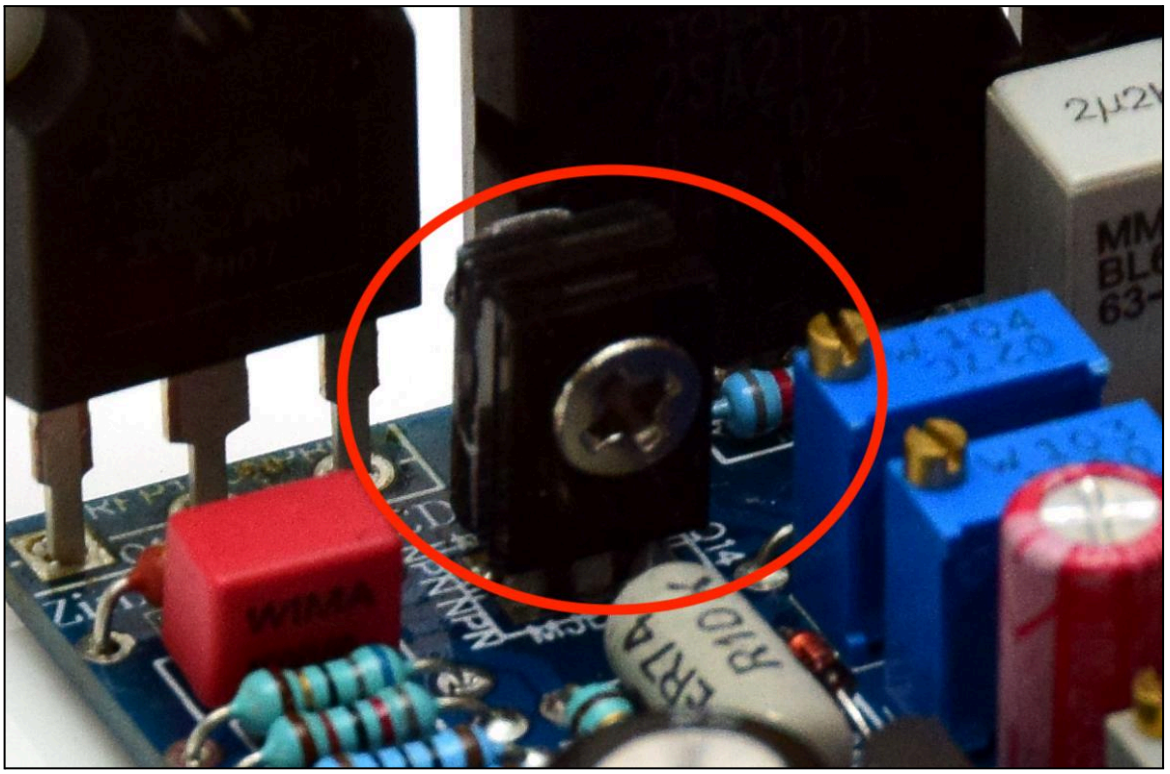
**Thermal Regulators:**

The image below shows the position of one of the bias-regulation transistors and how it is clamped to the output pre-driver with an M3 nut and bolt.

There are two pairs of adjacent transistors - one on the left and one on the right. Each pair consists of one bias transistor and one output pre-driver. As the pre-driver warms, it heats the bias transistor and reduces the bias to prevent thermal runaway.

Both pairs of transistors must be held together with an M3 bolt and nut.

If the regulators are not firmly touching their respective devices, thermal runaway will occur and the output devices will overheat and fail within a couple of minutes.




**Do not switch on if you have not bolted these two pairs of transistors together. The amplifier will overheat and fail within seconds!**

**Assembly - steps**

Self-assemblers, please follow these steps to avoid costly and hazardous mistakes. Please avoid the temptation to solder in all components and then switch on; this will likely result in failure (smoke & damage etc).

You need to assemble and test the board in the following stages:

1. Solder in all components, except for the large output devices and two resistors - R19 and R18. These are both 82R. Leaving these resistors in will cause instability during the first power-up test (step 2), so ensure to leave them out.

2. Attach the -48v GND +48v terminals to the power supply, ensuring the ground terminal is properly grounded to the star-earth/hub

3. Connect the pre-amp output to the input terminals of the power amp. If you are not using a preamp, ensure the IN-GND pin is connected to the star-earth/hub

4. Apply the power

5. Check for any obvious signs of smoke or heat. There should be none

6. Check the voltage between the speaker output terminal and the ground. It should be between -200mV and +200mV. If it is much more than that, you have assembled the PBC incorrectly. Switch off, disconnect the power and investigate!

7. Check the voltages across R29 and R30. These should be approximately 20v and both be the same. If these voltages are more than two volts apart, there is an assembly problem. Switch off, disconnect the power and investigate!

8. Solder in the remaining components and Attach the module firmly to the heatsink as described on the previous page.

9. Proceed to the **Biasing steps** in the next section. Pay particular attention to getting the output transistors in their correct positions. Placing the PNP device where the NPN device should be - for example - is guaranteed to destroy the devices at switch-on.

**Biasing - steps**

1. **Set the Bias to zero:** Before switching on, take a small flat-head screwdriver and rotate the Class A and Class B trimmer pots clockwise until they click - this may take up to 25 whole turns of each trimmer pot. This will de-bias the Class A and Class B devices.

2. **Power On:** Only if your amplifier is correctly assembled and firmly attached to the heatsink, switch on the power to your amplifier.

3. **Check the DC Offset of the Speaker output:** with a small screwdriver, turn the 'Offset' trimmer (VR1) until the voltage between the ground and the speaker output (Spk) is close to zero (+/- 10mV). Once you have done this, proceed to step 4.

4. Measure the voltages across R17 (1Ω) and R21 (1Ω) with a multimeter - see PCB layout below. These voltages should be very similar and between 0 and 80mV (0-80mA). If they are different, do not proceed as there is a problem.

**The target bias measurement for Class A is 150mV (150mA).**

5. To Bias the Class A stage, rotate the Class A trimmer anti-clockwise 3 whole turns (like opening a tap) and check the voltages across either R17 or R21. Repeat, one whole turn at a time, until these voltages begin to rise past 50mV. Smaller turns will be required beyond 50mV, so be patient :-) Continue until you reach 180-190mV. The bias voltage will then begin to fall back to 150mV as the thermal compensation takes effect. Make small adjustments to maintain 150mV and check the voltage across both R17 and R21 are still the same.

**The target bias measurement for Class B is 5mV (50mA)**

6. To bias the Class B stage, rotate the Class B trimmer anti-clockwise two whole turns and measure the voltage across R34 and R36 (0.1ohm). Repeat, one turn at a time, until these voltages are between 2 and 5 mV (20-50mA). Don't be tempted to open the trimmer right up straight away - be patient :-) Continue until you see 5mV (50mA) across either R34 or R36. You may notice the voltage beginning to climb quickly. Turn the screw clockwise to reduce the bias back to 5mV.

7. With both Class A and B stages biased the amplifier will begin to warm more quickly and the thermal compensator will cause both biases to drop. Recheck the class A bias and adjust back to 150mV (150mA). This will cause the Class B bias to increase as well, so immediately check and adjust the Class B bias back to 5mV (50mA).

8. Run the amplifier for 15 mins with the cover on and recheck these voltages. Adjust if necessary. Check again after 1 hour of playing music. Class A should be just approx 150mV and Class B approx 5mV. If the amplifier is too warm for comfort, reduce the Class A bias slightly e.g to 120mV; it won't hurt the sound.

**Parts List:**

CONNECTORS: Both blank and ready-built PCB require connectors be purchased and soldered on by the constructor. This is to give the constructor a choice of how they wire their own particular installation. Terminal block connectors are indicated in the list below in blue and can be swapped for equivalent 2.54mm pitch connectors e.g. Molex KK254 headers, which are provided to the constructor in kits with ready-made wiring.

PLEASE NOTE THE QUANTITIES BELOW ARE FOR ONE **PAIR** OF POWER AMPS (L & R):

Email parts@zinamp.co.uk for help

| Designator | Value/Spec | Qty | Supplier | Manufacturer | Manuf Part | RS Part |
|---|---|---|---|---|---|---|
| R38,R29,R30 | 2.7k | 6 | RS | TE Connectivity | LR1F2K7 | 125-1161 |
| R9,R15 | 15k | 4 | RS | TE Connectivity | LR1F15K | 125-1165 |
| VR2 | 20k | 2 | RS | Bournes | 3296W-1-203LF | 521-9710 |
| R16,R20,R22,R25,R28 | 22R | 10 | RS | TE Connectivity | LR1F22R | 148-095 |
| R2,R5,R7,R10,R33,R41 | 100R | 12 | RS | TE Connectivity | LR1F100R | 125-1155 |
| VR3,VR1 | 1k | 4 | RS | Bournes | PV36W102C01B00 | 181-4455 |
| Q1,Q3,Q4 | MPSA92 | 6 | RS | Diodes/Zetex | ZTX558 | 669-7663 |
| Q7 | MPSA42 | 2 | RS | OnSemi | KSP44TA | 671-1144 |
| R6,R11,R23,R35,R18,R19 | 82R | 12 | RS | Vishay | MBB02070C8209FCT00 | 506-4784 |
| Q8,Q13,Q16 | MJE350 | 6 | RS | ST | MJE350 | 486-4577 |
| Q17,Q18 | MJE340 | 4 | RS | ST | MJE340 | 714-0997 |
| R1,R4,R31,R40,R14,R24,R42 | 470R | 14 | RS | TE Connectivity | LR1F470R | 125-1158 |
| C11 | 1u 40vAC | 2 | RS | Epcos | B32529C0105J000 | 896-1304 |
| R32,R39 | 47k | 4 | RS | TE Connectivity | LR1F47K | 148-893 |
| D1,D2,D3,D4,D5,D6,D9,D10 | 50v 1A | 16 | RS | Vishay | 1N4001-E3/54 | 628-8931 |
| Q15,Q5 | 2N4403 | 4 | RS | OnSemi | 2N4403 | 739-0445 |
| Q14,Q2,Q6 | 2N4401 | 6 | RS | OnSemi | 2N4401 | 739-0439 |
| SIG-IN, Out | -\|+ | 4 | RS | Vishay | MRS25000C3901FCT00 | 683-3641 |
| POWER | -\|GND\|+ | 2 | RS | TE Connectivity | LR1F47K | 148-893 |
| R3,R13 | 22k | 4 | RS | TE Connectivity | LR1F22K | 125-1167 |
| C8 | 47u 25v | 2 | RS | Rubycon | 25YXF47M5X11 | 191-8249 |
| L1 | 3.3uH | 2 | RS | Bournes | RLB0912-3R3ML | 811-8884 |
| C4,C5 | 100u 63v | 4 | RS | Panasonic | ECA1JM101 | 790-1098 |
| Q9,Q11 | 2SA | 4 | RS | Toshiba | 2SA1943N | 890-2620 |
| Q10,Q12 | 2SC | 2 | RS | Toshiba | 2SC5200N | 890-2689 |
| C2,C18,C19 | 100p | 6 | RS | Wima | FKP2/100/100/5 | 484-1978 |
| C1 | 2.2u | 2 | RS | Panasonic | ECWF2W225JA | 727-0164 |

| | | | | | | |
|---|---|---|---|---|---|---|
| R26,R37 | 10R | 4 | RS | TE Connectivity | LR1F10R | 125-1154 |
| R8,R12,R27 | 1k | 6 | RS | TE Connectivity | LR1F1K0 | 125-1159 |
| R17,R21 | 1R | 4 | RS | Vishay | PR01000101008JA100 | 683-5357 |
| C7,C10 | 220p | 4 | RS | Wima | FKP2/220/100/5 | 484-1984 |
| R34,R36 | 0.1R 3W | 4 | RS | TE Connectivity | ER74R10KT | 158-569 |
| C9,C6 | 100u 35v | 4 | RS | Panasonic | ECA1VM101 | 228-6767 |
| C13,C14,C12,C3 | 100n | 8 | RS | Epcos | B32529C1104K189 | 241-6575 |

**Parts available from RS Online. Also try Farnell, Mouser and other online suppliers.**

**Parts from different manufacturers can be substituted where spec is sufficient**

**Supplier trading names may differ by country.**