The CLASSiC-D ±35V DC-DC Converter

Delivers up to ±35V and 125W from a 12V battery with high efficiency

By JOHN CLARKE

This compact ***DC-DC Converter*** was designed to mate with our ***CLASSiC-D Amplifier*** (published in November and December 2013). It presents an efficient way to run the ***CLASSiC-D Amplifier*** module from a battery to make it a compact powerhouse. Of course, it can also be teamed up with other amplifier modules too, if you already have them on hand, and its output voltage can be adjusted over a small range.

THIS DC-DC CONVERTER is designed to deliver ±35V DC supply rails from a 12V DC input. At that setting, it will enable the *CLASSiC-D Amplifier* to deliver some 100W into 4Ω and 60W into 8Ω. This is certainly less than the *CLASSiC-D's* maximum output of 250W when powered from ±55V supply rails, but we have chosen this setting as a good compromise between power output and battery life.

And while the *DC-DC Converter* can be used with other power amplifier modules which have a similar supply rail requirement, they will not be as efficient as the *CLASSiC-D* module and therefore will not give you as much audio output for a given battery current.

The *Converter* is housed in a rugged diecast box measuring just 119mm ×

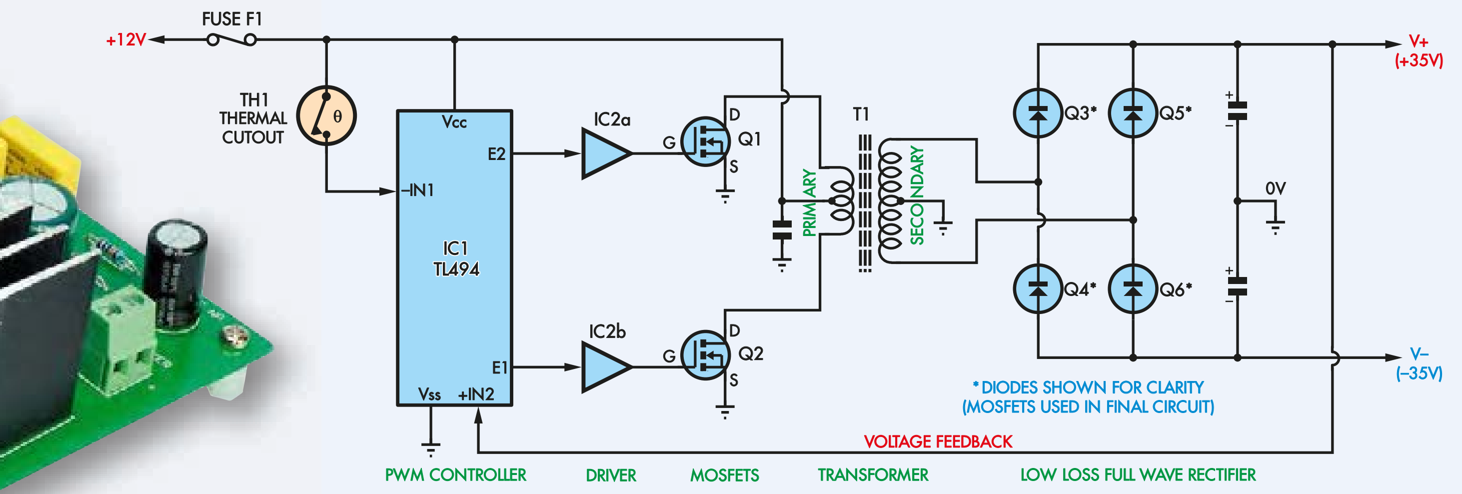


Fig.1: a simplified diagram of the *DC-DC Converter*. It uses a TL494 switch-mode PWM controller (IC1) to drive MOSFETs Q1 and Q2 in anti-phase and these drive transformer T1 at about 25kHz. The transformer secondary then drives a rectifier stage to derive ±35V rails.

94mm × 57mm. Just add the CLASSiC-D Amplifier module and a 12V SLA battery and you have the basis for a powerful portable PA amplifier or a really punchy busking amplifier, with good battery life.

Main Features and Specifications

Features

- Compact housing
- Efficient rectifier circuitry
- Thermal shutdown
- Fuse protection
- Power indication

Specifications

Power supply: 11.5-14.4V using a 12V battery (or 24V with modifications)

Power rating: 50W continuous, 125W peak (enables the CLASSiC-D Amplifier to deliver up to 100W into 4Ω on normal program material)

Standby current: 130mA at 12.6V

Standby Current with CLASSiC-D Amplifier connected: 220mA in protect mode; 490mA in run mode with no signal

DC supply ripple at 60W load: less than 2V

DC-DC converter basics

The *DC-DC Converter* works by alternately switching 12V to each half of a centre-tapped transformer primary winding. The resulting AC waveform is then stepped up in the transformer's centre-tapped secondary, rectified and filtered to provide the plus and minus supply rails.

Fig.1 shows the basic schematic of the *DC-DC Converter*. It operates at a switching frequency of about 25kHz and uses a high-frequency ferrite transformer. MOSFET Q1 drives the top half of the step-up transformer, while Q2 drives the bottom half. The secondary winding's centre-tapped output is fed to a bridge rectifier and filter capacitor stages to develop the plus and minus DC output rails.

The MOSFETs are driven via separate drivers, IC2a and IC2b, by a TL494 switchmode chip (IC1) which has feedback to keep the positive DC voltage to a set value (ie, 35V). This feedback controls the width of the pulses applied to the gates of the MOSFETs. If the voltage rises above the set value, the width of the gate pulses is reduced, and vice versa. The two MOSFETs are switched in anti-phase, so that when one half of the winding is conducting, the other is off.

Fig.1 shows the rectifiers as diodes, but in reality they are MOSFETs, hence the Q numbers (eg, Q3). The reason for using MOSFETs instead of fast recovery diodes is that they are far more efficient, since they have less forward voltage drop than diodes.

The circuit also incorporates a low voltage cut-out and over-temperature protection. If the battery voltage drops below 11.5V, the converter switches itself off. This is essential if you are powering the converter from a 12V SLA battery. If these batteries are allowed to discharge much below 11.5V, they will be rendered useless. That can be expensive and frustrating!

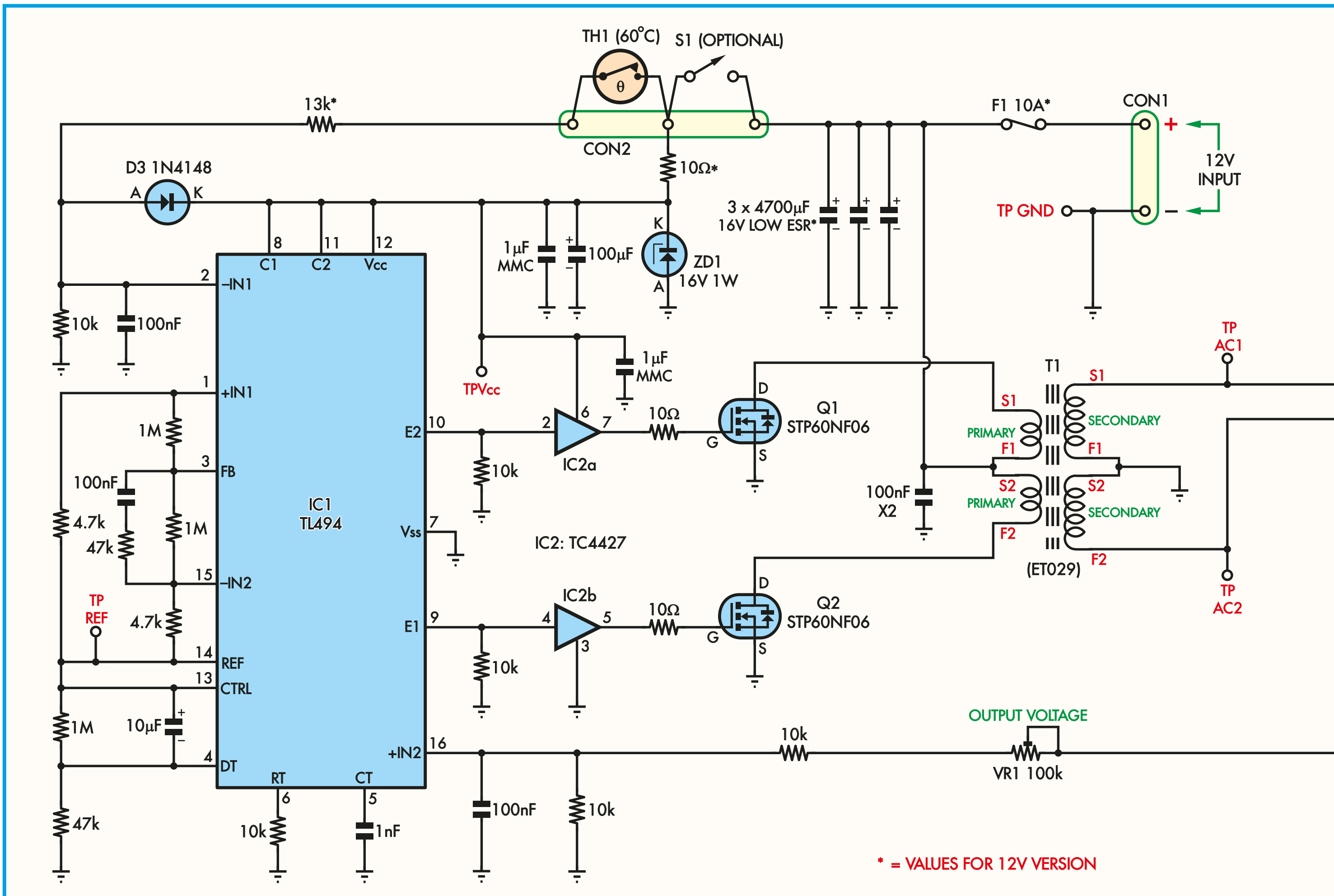
Over-temperature protection is provided by a thermal cut-out attached to the inside of the diecast case. If the case temperature exceeds 60°C, the thermal cut-out opens and the converter shuts down. When it cools sufficiently, normal operation resumes, with no harm done.

Circuit details

Fig.2 shows the full circuit of the *CLASSiC-D DC-DC Converter*, while Fig.3 shows the internal circuitry of the TL494. It is a fixed-frequency pulse-width modulation (PWM) controller containing a sawtooth oscillator, two error amplifiers and a PWM comparator. It also includes a dead-time control comparator, a 5V reference and output control options for push-pull or single-ended operation.

The PWM comparator generates the variable width output pulses by comparing the sawtooth oscillator waveform against the outputs of the two error amplifiers. The error amplifier with the highest output voltage sets the pulse width.

Pin 13 selects single-ended output or push-pull operation. In our design, push-pull operation is selected and



CLASSIC-D DC-DC CONVERTER

Fig.2: the full circuit of the *CLASSiC-D DC-DC Converter*. It uses MOSFETs Q3-Q5 to rectify the AC from transformer T1's secondary and these are controlled by four IR11672 secondary-side driver (SSD) ICs (IC3-IC6). Each SSD monitors the voltage across its MOSFET to determine when to switch the MOSFET on or off via the V_{GATE} output.

the outputs appear at the transistor emitters, with the collectors tied to the positive supply.

Dead-time comparator

The dead-time comparator ensures that there is a brief delay between one output going high and the other going low. This means that the outputs at pins 9 and 10 are both low for a short time at the transition points.

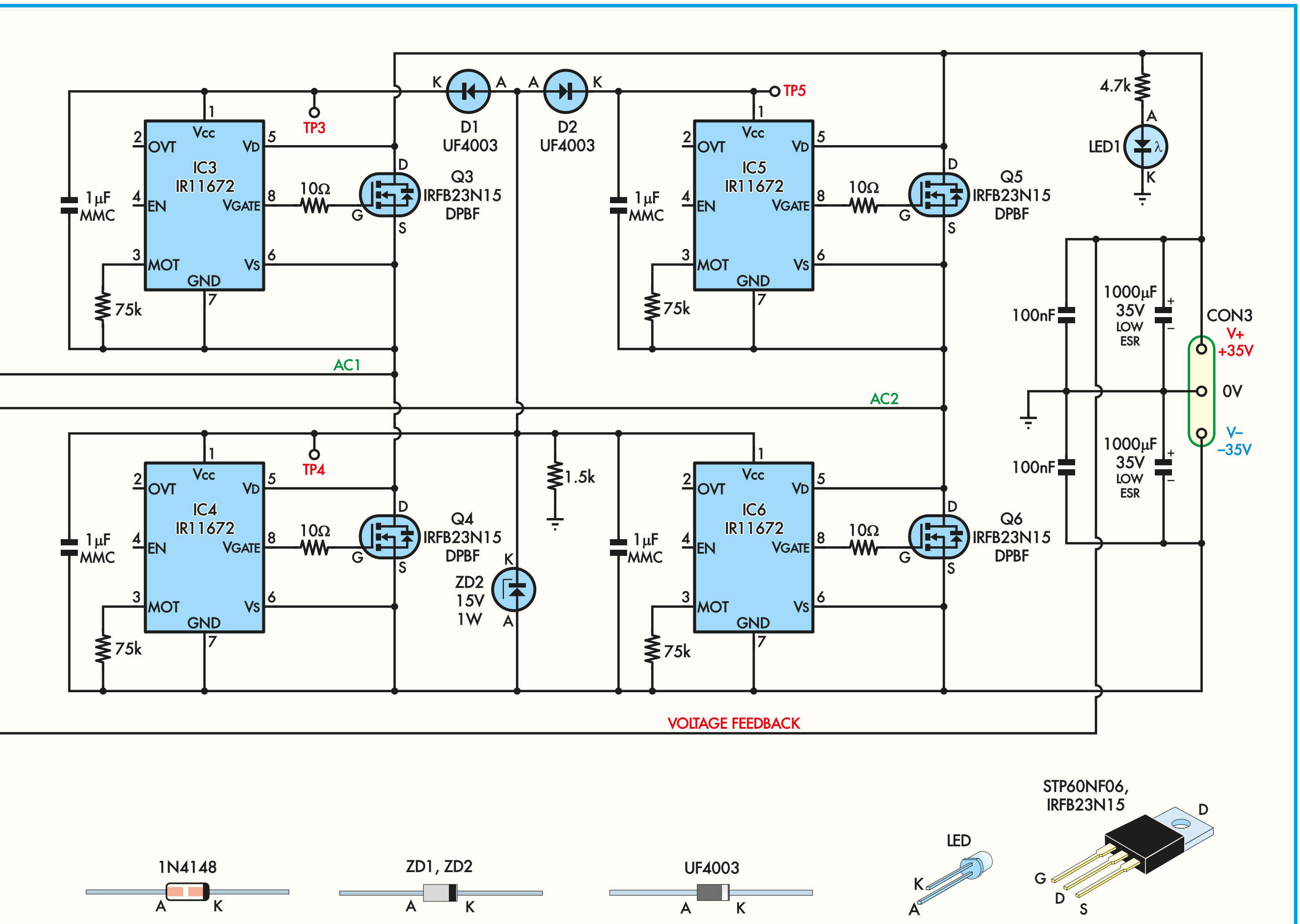
This dead-time period is essential, since without it, the MOSFET driving one half of the transformer would still be switching off while the other MOSFET would be switching on. This would destroy both MOSFETs as they would effectively create a short circuit across the 12V supply.

One of the error amplifiers in IC1 is used to provide the under-voltage protection. Pin 2 monitors the +12V rail via a voltage divider consisting of 10kΩ and 13kΩ resistors. Non-inverting input pin 1 connects to IC1's internal 5V reference at pin 14 via a 4.7kΩ resistor. When the voltage at pin 2 drops below 5V (ie, when the battery voltage drops below 11.5V), the output of the error amplifier goes high and the PWM outputs at pins 9 and 10 go low, thus shutting the circuit down. The 1MΩ resistor between pins 1 and 3 provides a small amount of hysteresis so that the output of the converter does not rapidly switch on and off if the battery is close to the 11.5V threshold.

The over-temperature protection operates with a 60°C thermal cut-out (TH1) connected in series between the voltage divider on pin 2 and the positive supply rail. If the case temperature reaches 60°C, TH1 opens and the circuit shuts down by turning the PWM off.

The second error amplifier in IC1 is used to control the output voltage of the DC-DC Converter. This amplifier has its inputs at pins 15 and 16. The feedback voltage is derived from the positive side of the bridge rectifier and is attenuated using a voltage divider consisting of VR1, a series 10kΩ resistor plus a 10kΩ resistor to ground. The resulting voltage is then fed to pin 16 of IC1 and compared to the internal 5V reference which is applied to pin 15 via a 4.7kΩ resistor.

Normally, the attenuated feedback voltage should be close to 5V. Should this voltage rise (due to an increase in the output voltage), the output of the error amplifier also rises and this reduces the output pulse width. Conversely, if the output falls, the error amplifier



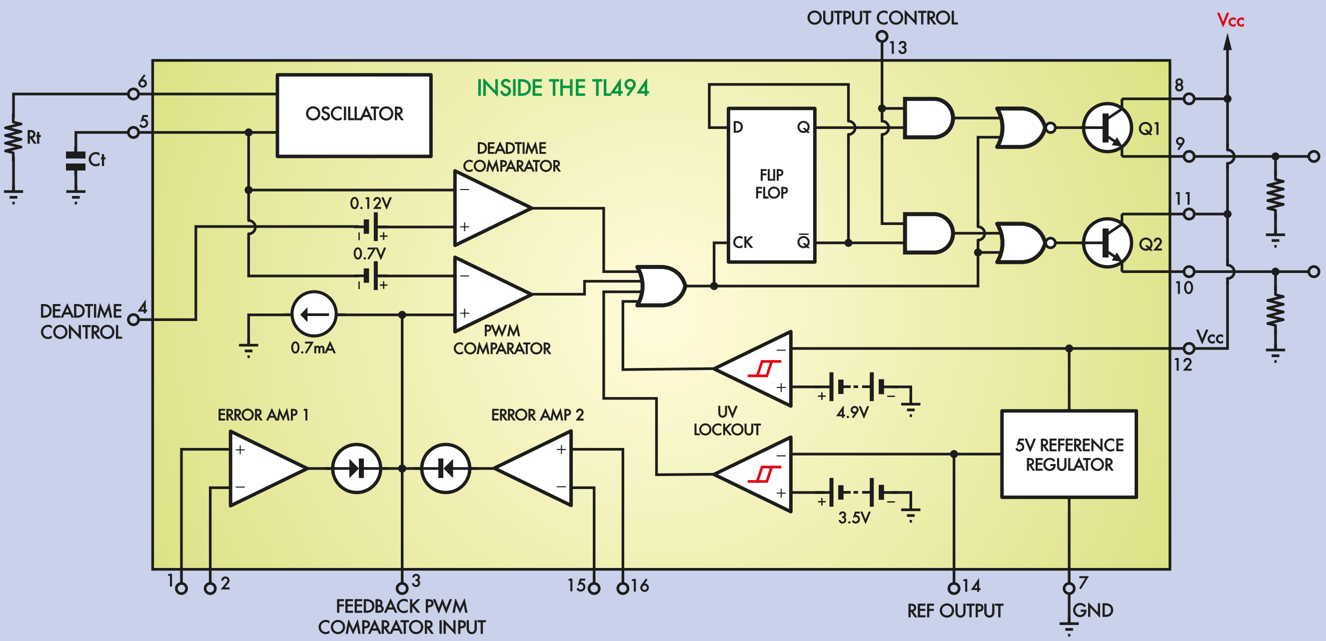


Fig.3: the internal circuit of the TL494 switch-mode pulse-width modulation (PWM) controller. It is a fixed-frequency PWM controller containing a sawtooth oscillator, two error amplifiers and a PWM comparator. It also includes a dead-time control comparator, a 5V reference and output control options for push-pull or single-ended operation.

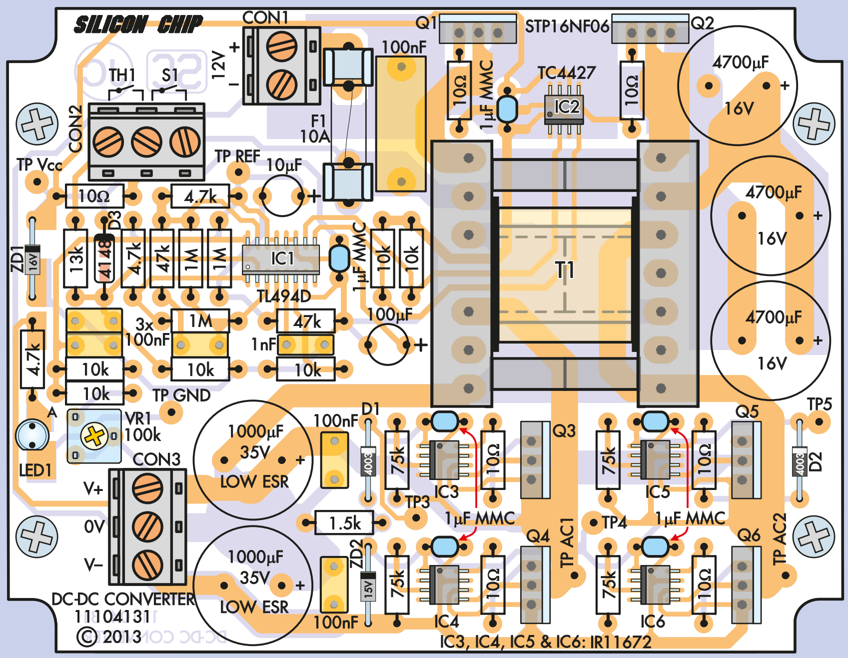


Fig.4: install the parts on the PCB as shown on this layout diagram, starting with the SMD ICs (IC1-IC6). Be sure to orient the ICs, MOSFETs, diodes, Zener diodes and electrolytic capacitors correctly

output also falls and the pulse width increases.

The gain of the error amplifier at low frequencies is set by the 1MΩ feedback resistor between pins 3 and 15 and by the 4.7kΩ resistor to pin 14 (V_{REF}). These set the gain to about 213. At higher frequencies, the gain is set to about 9.5 by virtue of the 47kΩ resistor and 100nF capacitor in series across the 1MΩ resistor. This reduction in gain at higher frequencies prevents the amplifier from responding to hash on the supply rails and ensures stability.

The 10kΩ resistor and 1nF capacitor at pins 6 and 5 respectively set the internal oscillator to about 50kHz. An internal flipflop divides this by two to give the complementary 25kHz output signals at pins 9 and 10. Note that while most of the inverter circuitry could run at much higher speed, 'skin effect' in the windings of the ferrite-cored inverter transformer sets the practical limit for switching the MOSFETs to around 25kHz.

Pin 4 of IC1 is the dead-time control input. When this input is at the same level as V_{REF}, the output transistors are off. As pin 4 drops to 0V, the dead-time decreases to a minimum. At switch on, the 10µF capacitor between V_{REF} (pin 14) and pin 4 is discharged. This prevents the output transistors in IC1 from switching on. The 10µF capacitor then charges via the 47kΩ resistor and so the duty cycle of the output transistors slowly increases until full control is gained by the error amplifier. This effectively provides a soft start for the converter.

The complementary PWM outputs at pins 10 and 9 of IC1 are fed to MOSFET drivers IC2a and IC2b, which drive the gates of Q1 and Q2. Note also the 100nF capacitor and the three 4700µF low-ESR capacitors between the centre tap of the transformer primary and the ground. These are included to cancel out the inductance of the leads which carry current to the transformer. They effectively provide the peak current required from the transformer as it switches.

MOSFET rectification

As previously mentioned, the AC from the transformer secondary is rectified by MOSFETs instead of a conventional diode bridge. This increases the overall efficiency of the DC-DC Converter.

The rectification process employs both the intrinsic diodes of the MOSFETs and their normal channel conduction. The intrinsic diode in a MOSFET is a reverse-connected diode that is part of the substrate layer. Originally, these intrinsic diodes were notoriously slow acting, but are now quite fast. Now, if the MOSFETs were prevented from conducting, their intrinsic diodes are connected to operate in the same way as a conventional bridge rectifier. The MOSFETs themselves are then controlled to act as 'helpers' for each diode, switching on when the intrinsic diodes begin to conduct and switching off just before reverse conduction.

Each MOSFET is controlled using an IR11672 secondary side driver (SSD). Each SSD monitors the voltage across its MOSFET to determine when to switch the MOSFET on or off via its V_{GATE} output.

When the voltage between drain and source is greater than –50mV, the MOSFET is switched on to bypass the intrinsic diode. When the voltage drops below -6mV, the MOSFET is switched off.

Using the MOSFETs saves valuable power compared to conventional diode rectifiers. For example, at a current of 3.5A, a Vishay V10150C Schottky diode would have a forward voltage close to 0.9V, resulting in a power loss of 3.15W for each diode.

By using the specified IRFB23N15 MOSFETs, the voltage drop at 3.5A is less at 0.25V, giving a power loss of 875mW. Overall, the Schottky diode rectification would have a 6.3W loss compared to 1.75W for the MOSFET rectifiers; remember that only two diodes are conducting at any one time. The low power dissipation means that these MOSFETs do not require heatsinking and the higher efficiency means less battery current for a given power output.

Of course, there is some power loss associated with the MOSFET drivers. This amounts to about 267mW for the four devices in the bridge.

The IR11672 includes a minimum on-period to prevent the MOSFET switching off immediately it switches on, which could otherwise happen due to the decreased voltage between drain and source. The minimum on time is set by the resistance at the MOT (Minimum On Time) terminal. Using the 75kΩ resistor, this is around 3µs.

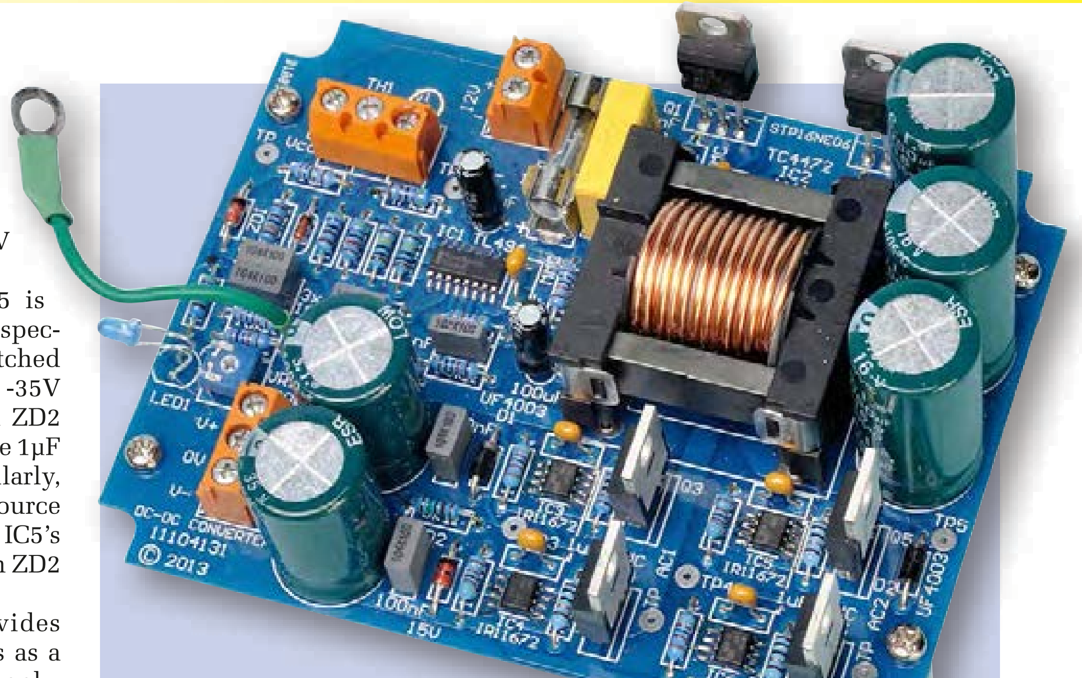
Note that the IR11672 is designed for high-frequency switchmode supply rectification up to 500kHz.

Power for each IR11672 is derived from the -35V supply rail via a 1.5kΩ resistor that feeds 15V Zener diode ZD2. The initial -35V supply is obtained by the rectification provided by the intrinsic diodes in the MOSFETs. Then, as each IR11672 receives a supply, rectification using the switched MOSFETs begins. Both IC4 and IC6 share the same common 15V supply via ZD2. This is possible because these ICs also share the common -35V supply as their negative rail.

The supply for IC3 and IC5 is derived via diodes D1 and D2 respectively. When MOSFET Q4 is switched on, Q3's source is pulled to the -35V supply rail and so power from ZD2 can flow through D1 to charge the 1µF supply capacitor for IC3. Similarly, when Q6 is switched on, Q5's source is pulled to the -35V supply and IC5's supply capacitor is charged from ZD2 via D2.

Indicator LED (LED1) provides power indication. It also serves as a minimum load for the +35V supply. This minimum load is required to match the load on the -35V supply that delivers power to Zener diode ZD2. Since it is the +35V supply that is monitored with IC1 for voltage regulation, the minimum load ensures that the PWM drive to maintain voltage regulation is sufficient to maintain the -35V supply.

For correct operation, it is important that this minimum load is not disconnected. So, if LED indication is not required, the LED connections on the PCB should be bridged to ensure that the LED resistor is still connected between the +35V supply and ground.



This view shows the completed PCB assembly. It's earthed to the metal case via an earth lead soldered to TP GND.

Construction

All the parts for the CLASSiC DC-DC Converter are mounted on a double-sided PCB available from the *EPE PCB Service*, coded 11104131, and measuring 110mm × 85mm. This fits neatly inside a metal diecast case measuring 119mm × 94mm × 57mm. The diecast case not only makes for a rugged assembly, but also provides shielding plus heatsinking for Q1 and Q2.

> **CAUTION**
>
> It's a good idea to switch off and let the 1000µF output filter capacitors discharge (ie, blue LED out) before connecting (or disconnecting) this DC-DC Converter to an amplifier.
>
> It's also a good idea to avoid touching the ±35V (70V total) supply rails during operation to avoid the possibility of a shock.

Fig.4 shows the parts layout on the PCB. Begin the assembly by installing IC1-IC6. These are all SMDs in SOIC packages and are quite easy to solder in place due to their (relatively) wide 0.05-inch pin spacing. Each IC is mounted on the top of the PCB and must be oriented as shown on the overlay diagram of Fig.4.

To solder an IC in place, align its leads over the PCB pads and tack solder pin 1 first. That done, check that the device is correctly aligned. If not, remelt the solder and adjust it as necessary. The remaining pins are then soldered, starting with the diagonally opposite pin (pin 16 or pin 8), after which you should resolder pin 1.

Don't worry if you get solder bridges between adjacent pins during this process. These bridges can be quickly cleared using solder wick – just press the solder wick against the bridge using a hot soldering iron. A dab of no-clean flux paste will aid this process.

Once all the ICs are soldered in, the next step is to install the remaining low-profile parts. Note that component values shown on Fig.4 are for a 12V supply. If you wish to use a 24V supply, then it will be necessary to change a few component values, as detailed in the accompanying panel.

Start with the resistors, diodes and Zener diodes. Table 1 shows the resistor

Table 1: Resistor Colour Codes

❑	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	3	1MΩ	brown black green brown	brown black black yellow brown
❑	4	75kΩ	violet green orange brown	violet green black red brown
❑	2	47kΩ	yellow violet orange brown	yellow violet black red brown
❑	1	13kΩ	brown orange orange brown	brown orange black red brown
❑	7	10kΩ	brown black orange brown	brown black black red brown
❑	3	4.7kΩ	yellow violet red brown	yellow violet black brown brown
❑	1	1.5kΩ	brown green red brown	brown green black brown brown
❑	7	10Ω	brown black black brown	brown black black gold brown

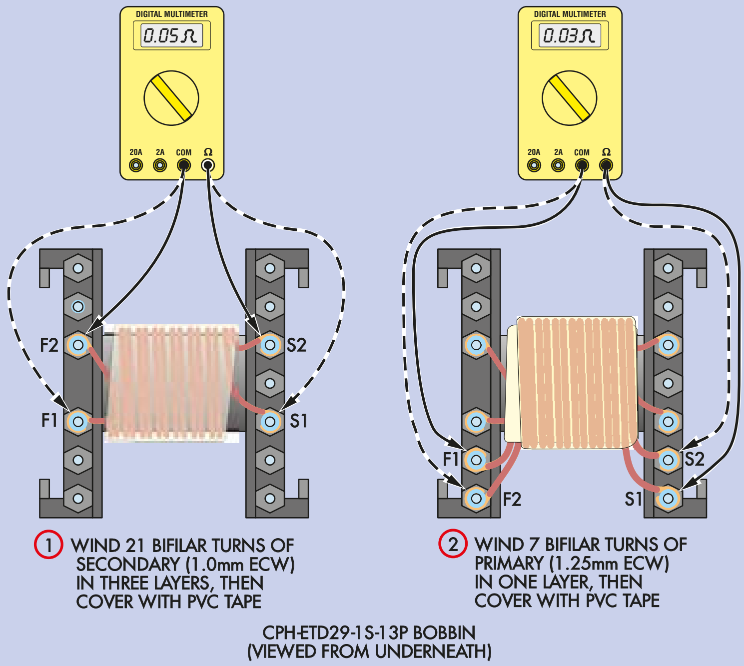


Fig.5: the winding details for transformer T1. The secondary is wound first using 21 bifilar turns of 1mm-diameter enamelled copper wire and is covered with a single layer of insulation tape. The primary is then wound on using seven bifilar turns of 1.25mm enamelled copper wire – see text.

Running the DC-DC Converter from 24V

Although we have not tested this DC-DC Converter at 24V, it can be done with some circuit changes. However, 24V operation is not ideal because the winding wire needs to be a smaller diameter so that the extra turns required can fit on the transformer bobbin.

For 24V operation, the secondary is wound with 21 turns of 0.8mm enamelled copper wire. The primary is then wound with 14 turns of 1mm enamelled copper wire. Note that this has to be run in two layers and so once completed, the wires will need to be run back across to the other side of the bobbin (ie, at right angles to the windings on the underside) to return the wire to the finish terminals.

In addition, the fuse must be changed to 5A, the capacitors changed from 4700µF 16V to 1000µF 35V, the 10Ω resistor for ZD1 changed to 1kΩ and the 13kΩ resistor at pin 2 of IC1 changed to 36kΩ. The parts list below shows the new parts.

Parts list changes for 24V operation

1 M205 5A fast blow fuse (F1) (instead of 10A)
5 1000µF 35V (instead of 3 × 4700µF 16V PC low-ESR electrolytic and 2 × 1000µF 35V PC low-ESR electrolytic)
1 1kΩ 0.25W resistor for ZD1 (instead of 10Ω)
1 36kΩ 0.25W resistor (instead of 13kΩ at pin 2, IC1)
1 2.6m length of 0.8mm-diameter enamelled copper wire for T1's secondary
1 1.8m length of 1mm-diameter enamelled copper wire for T1's primary

colour codes, but you should also check the values with a multimeter, as some colours can be difficult to distinguish.

Be sure to orient the diodes and Zener diodes as shown on Fig.4. The Zener diode type numbers are shown in the parts list.

The PC stake at TP GND is next on the list, followed by LED1. The latter is mounted with its leads bent down by 90°, so that its lens can later be pushed through a matching hole in the side of the case. To install it, bend its leads down about 3mm from its body, then solder it in position so that the centre line of its body sits about 9mm above the PCB.

Be sure to install the LED with the correct orientation. Its anode lead is the longer of the two.

MOSFETs Q1-Q6 can now go in. These should be installed so that the tops of their metal tabs are 20-25mm above the PCB.

Follow with the capacitors. The electrolytic types must all be oriented with the correct polarity (ie, with the negative side towards the left edge of the PCB). Once they're in, install trimpot VR1, then fit screw terminal blocks CON1, CON2 and CON3.

Now fit the fuse clips. These each have an end stop at one end, so that the fuse will not slip out when installed. Make sure these end stops go to the outside, otherwise you will not be able to later install the fuse.

Transformer winding

The PCB assembly can now be completed by winding and fitting the transformer. Fig.5 shows the winding details for the 12V version (refer to the accompanying panel for the winding details for the 24V version).

The secondary windings are wound on the bobbin first. Begin by cutting a 2.6m length of 1mm-diameter enamelled copper wire into two 1.3m lengths. That done, strip 5mm of the enamel insulation from one end of each wire using a hobby knife, then solder these wires to terminals S1 and S2 (start) as shown in Fig.5 (these go on the side with the seven terminals).

Now carefully wind on seven bifilar turns (ie, both wires laid side by side) to the opposite side of the bobbin, then another seven turns back towards the start terminals and finally another seven turns back to the opposite side (ie, 21 bifilar turns in all). Once all the turns are on, secure them in place using a single layer of insulation tape, cut to fit the width of the bobbin.

Now set your multimeter to read 'ohms' and use it to determine which wire is connected to S1. That done, trim this wire to length, strip 5mm of enamel insulation from the end and solder it to terminal F1. The other wire is then connected to F2.

Finally, use your multimeter to confirm that there is close to zero ohms between S1 and F1 and close to zero ohms between S2 and F2. Check also that there is a high impedance (>1MΩ) between the windings, eg, between S1 and S2.

The primary winding is also bifilar wound but consists of just seven turns of 1.25mm enamelled copper wire. Note that the orientation of the bobbin is also important when installing this winding.

First, check that the bobbin is oriented so that the side with the six terminals is to the left, as shown in Fig.5 (ie, with the terminals facing towards you). That done, cut a 900mm length of 1.25mm enamelled copper wire in half, strip one end of each wire and solder them to the primary S1 and S2 terminals.

Now wind on seven bifilar turns in the direction shown, taking care to ensure that the wires are close together (otherwise they won't fit into the bobbin). Cover this winding with another layer of insulation tape, then identify which wire connects to S1 and connect it to F1. The other wire is then connected to terminal F2.

Note that the primary F1 and S1 terminals are diagonally opposite each other, as are S2 and F2. By contrast, S1 and F1 are directly opposite each other for the secondary winding (as are S2 and F2).

Once again, use a multimeter to confirm that S1 and F1 are connected, that S2 and F2 are connected, and that there is a very high impedance between the two windings. Check also that there is no connection between any of the primary and secondary windings.

Once the windings are in place, the transformer assembly is completed by sliding the two ferrite cores into the bobbin and securing them in place using the supplied clips. The transformer can then be installed on the PCB.

Parts List

- 1 double-sided PCB, available from the *EPE PCB Service*, code 11104131, 110mm × 85mm
- 1 diecast box, 119mm × 94mm × 57mm
- 1 ETD29 transformer (T1) (1 × 13-pin former [element14 Cat. 1422746], 2 × N87 cores [element14 Cat. 1781873], 2 × clips [element14 Cat. 178507]
- 1 thermostat switch (60°C, normally closed)
- 2 IP68 cable glands, 4-8mm cable diameter
- 1 2-way screw terminals (5.08mm pitch) (CON1)
- 2 3-way screw terminals (5.08mm pitch) (CON2,CON3)
- 2 M205 PCB-mount fuse clips
- 1 M205 10A fast-blow fuse (F1)
- 1 SPST or SPDT toggle switch (S1) (optional – see text)
- 4 M3 × 9mm tapped spacers
- 2 TO-220 silicone insulation washers
- 2 insulating bushes
- 2 M3 × 10mm screws
- 6 M3 × 6mm screws
- 4 M3 × 6mm countersunk screws
- 4 M3 nuts
- 1 solder lug
- 1 2.6m length of 1mm enamelled copper wire (for T1 secondary)
- 1 900mm length of 1.25mm enamelled copper wire (for T1 primary)
- 1 length of 24/0.2mm (0.75mm^2 cross section) figure-8 cable
- 3 lengths of 19/0.18mm (0.48mm^2 cross section) or 14/0.2mm (0.44mm) wire
- 1 200mm length of medium-duty hookup wire
- 1 PC stake (TP GND)

Semiconductors
- 1 TL494CDR SOIC-16 switch-mode pulse-width modulation controller (IC1)
- 1 TC4427ACOA SOIC-8 Dual MOSFET Driver (IC2) (element14 Cat. 1467705)
- 4 IR11672ASPBF SOIC-8 Smart Rectifier Controller (IC3-IC6) (element14 Cat. 1827123)
- 2 STP60NF06 N-channel MOSFETs (Q1,Q2)
- 4 IRFB23N15DPBF 150V, 23A N-channel MOSFETs (Q3-Q6) (element14 Cat. 8648735)
- 2 UF4003 fast rectifier diodes (D1,D2)
- 1 1N4148 switching diode (D3)
- 1 16V 1W Zener diode (1N4745) (ZD1)
- 1 15V 1W Zener diode (1N4744) (ZD2)
- 1 3mm blue LED (LED1)

Capacitors
- 3 4700µF 16V low-ESR electrolytic
- 2 1000µF 35V low-ESR electrolytic
- 1 100µF 16V electrolytic
- 1 10µF 16V electrolytic
- 6 1µF 50V monolithic multilayer ceramic (MMC)
- 1 100nF X2 class 275VAC MKP metallised polypropylene
- 5 100nF 63/100V MKT
- 1 1nF 63/100V MKT

Resistors (0.25W, 1%)

3 1MΩ	6 10kΩ
4 75kΩ	3 4.7kΩ
2 47kΩ	1 1.5kΩ
1 13kΩ	7 10Ω

- 1 100kΩ mini horizontal trimpot (VR1)

Preparing the case

You now have to drill holes in the diecast box to mount the PCB and to mount Q1 and Q2 and the thermal switch. Another hole is required for the LED, while two large holes are required to accept cable glands.

First, sit the PCB assembly inside the box and mark out the four mounting holes. Drill these out to 3mm in diameter and countersink them from the outside to suit the specified countersunk screws.

That done, attach four M3 × 9mm nylon spacers to the PCB assembly using M3 × 6mm screws, then sit the PCB inside the diecast box. Once it's in position, mark out the mounting holes for the tabs of MOSFETs Q1 and Q2 plus a hole at one end to accept the indicator LED.

Drill these out to 3mm in diameter, then slightly countersink the holes for Q1 and Q2 to remove any sharp edges. This is necessary to prevent damage to the silicone insulating washers that fit between the MOSFET tabs and the case (a sharp edge could puncture a washer and short a metal tab to the case).

The cable glands are placed 15mm down from the top of the case and 20mm in from the sides (see photo). The thermal cut-out is mounted midway between the two cable glands, with its top mounting hole 7mm down from the top edge of the case.

It's a good idea to solder an M3 nut to one lug of the thermal cut-out. This can then be lowered into the mounting position, making the unit easier to attach when the PCB is in place.

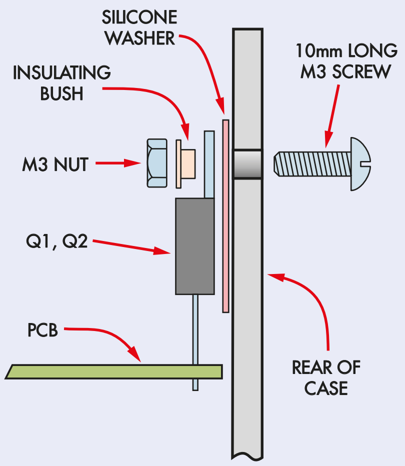


Fig.6: the mounting details for MOSFETs Q1 and Q2. The metal tab of each device must be isolated from the case using an insulating bush and a silicone washer.

Using the converter to power the SC480 amplifier

If you want to run a pair of SC480 amplifier modules using this DC-DC Converter, you can do so, but they will give slightly less than their specified power output since they were originally designed to run from ±40V rails. However, they will run quite happily from ±35V.

Once all the holes have been drilled, install the PCB assembly in the case and secure it using four countersunk screws.

Attaching Q1 and Q2

Q1 and Q2 are each attached to the side of the case using an M3 × 10mm screw and nut, along with a silicone insulating washer and an insulating bush. Fig.6 shows the details. Do the screws up firmly, then use a multimeter to check that both tabs are correctly isolated from the case.

You can do this by measuring the resistance between the case and the MOSFET tabs. You should get a high ohms reading in each case, but the meter may initially show a low ohms reading as various on-board capacitors charge up when the probes are connected. A permanent zero ohms reading means that there is a short which has to be fixed.

The case itself is earthed to the GND PC stake on the PCB via a short length of hook-up wire. That's done by first attaching a solder lug to one end of the wire, then attaching this to the case using the same mounting screw that's used to attach the top lug of the thermal cut-out. The other end of the wire is then soldered to the GND stake.

Once it's in place, fasten the bottom mounting lug of the thermal cut-out to the case, then solder two 80mm-long leads to its terminals and insulate these with heatshrink. The other ends of these leads can then be stripped and connected to the TH1 terminals on CON2.

The S1 switch terminals on CON2 can either be connected to an external switch or simply bridged with a short piece of tinned copper wire. The switch (or bridging wire) does not carry significant current (less than 50mA), since it doesn't carry the full DC-DC Converter current.

Basically, S1 will probably only be needed if there's no power switch for the external power supply.

Completing the assembly

The assembly can now to completed by installing fuse F1 and connecting the power supply leads. The supply leads can be made using a suitable length of 24/0.2mm (0.75mm^2) figure-8 wire. Connect the striped lead to the negative terminal of CON1 and the other lead to the positive terminal.

You can use a pair of needle-nose pliers to push the wires into their terminals on CON1.

Testing

Before connecting the external supply, go over the assembly carefully and check that the parts are all correctly positioned. In particular, check that the electrolytic capacitors are the right way around as these things have a nasty habit of exploding if they are installed with reverse polarity.

That done, wind trimpot VR1 fully anticlockwise, then fit the lid on the case (just in case an electrolytic is in the wrong way around).

If possible, use a current-regulated power supply to initially test the DC-DC Converter. If you don't have one, then a non-regulated supply or a 12V battery can be used. Be sure to get the supply polarity correct; if you connect it the wrong way around, the fuse will blow.

Once it's hooked up, apply power and let the unit run for several minutes. If it powers up safely (ie, no explosions from capacitors), you can then remove the lid and check the voltages between the 0V and the +35V and -35V terminals on CON3. With VR1 wound fully anticlockwise, you should get around +10V and -10V on these terminals.

Assuming all is well, carefully rotate VR1 clockwise until you get +35V and -35V readings. **Do not set the outputs any higher than ±35V, as the output capacitors are not rated for higher voltages (ie, they only have a 35V rating).**

Finally, the three output leads can be made up using 24/0.2mm wire and connected to CON3. The other ends of these leads can then be fitted with coloured heatshrink sleeves to identify them: red for +35V, green for 0V (GND) and blue for -35V.

Your new *DC-DC Converter* is now ready for use with the *CLASSiC-D Amplifier*. However, before connecting it up, the amplifier needs a few minor modifications in order to operate from ±35V rails – see the above panel.

Modifying the CLASSiC-D Amplifier For ±35V rails

As presented in the November and December 2013 issues of *EPE*, the CLASSiC-D Amplifier is designed for ±50V (or ±55V) supply rails. However, if you intend using this DC-DC Converter to power the amplifier, you need to make a few changes to the amplifier to suit the converter's lower ±35V supply rails.

This involves changing several resistors and Zener diodes, as shown in Table 1 on page 30 of the December 2013 issue (ie, in the article describing the construction of the CLASSiC-D Amplifier module). The new Zener diode type numbers are shown in Table 2.

Once the necessary parts have been changed in the amplifier, the supply wires from the DC-DC Converter can be connected to it using three lengths of 19/0.18mm (0.48mm^2 cross section) or 14/0.2mm (0.44mm^2) wire. Make sure the connections are made with the correct polarity.

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