BUILD AN ISOLATION TRANSFORMER FROM RECYCLED PARTS (UPDATED)

By Bruce Pierson

Above: This old UPS was rebuilt and converted into an Isolation Transformer.

This is NOT a project suitable for beginners or the inexperienced! This project should only be undertaken by constructors experienced in working with mains-powered circuits. Mains voltage can kill you.

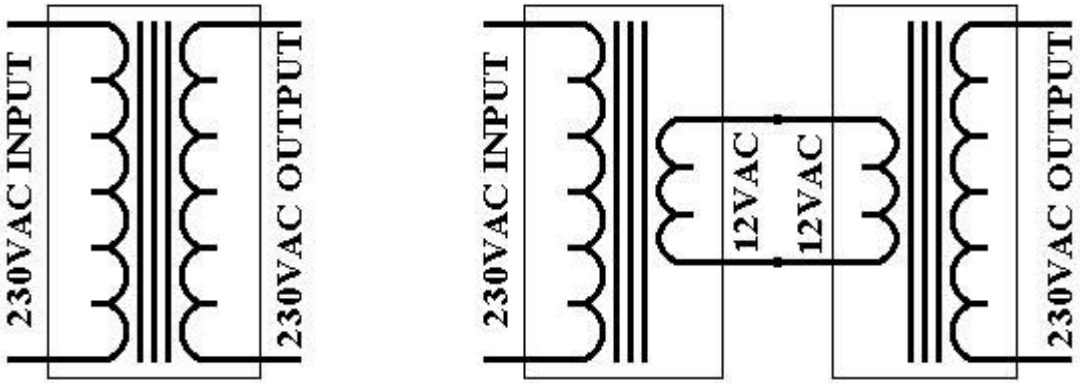
If you have an occasional need for an Isolation Transformer, but you can't justify spending between $200 and $400 to purchase one, then this simple project could be the answer. If you happen to have a couple of old UPSs lying around that no longer work, you can convert one into an isolation transformer using a part from the other.

So, what is an Isolation Transformer? In simple terms, you feed in 230VAC from the mains and you get out 230VAC that isn't connected to the mains. Why would you want to do this? There are a number of reasons. The mains power has three wires, Active, Neutral and Earth. Neutral and Earth are at ground or zero potential, whereas Active is at 230VAC, which can kill you if you happen to grab hold of it.

With an Isolation Transformer, you can safely touch either wire, but not both at once, because if you touch both at once, you'll get killed just as easily as if you grab the Active wire from the mains. If you are working on mains powered equipment with a “live chassis”, then an Isolation Transformer is a must for safety while working.

Another situation would be if you have an earthed appliance that has a slight earth leakage. If you don't have a safety switch, this appliance will happily function normally without any problems. However, if you have a safety switch, then you can expect the safety switch to be tripped either repeatedly or on a semi-regular basis.

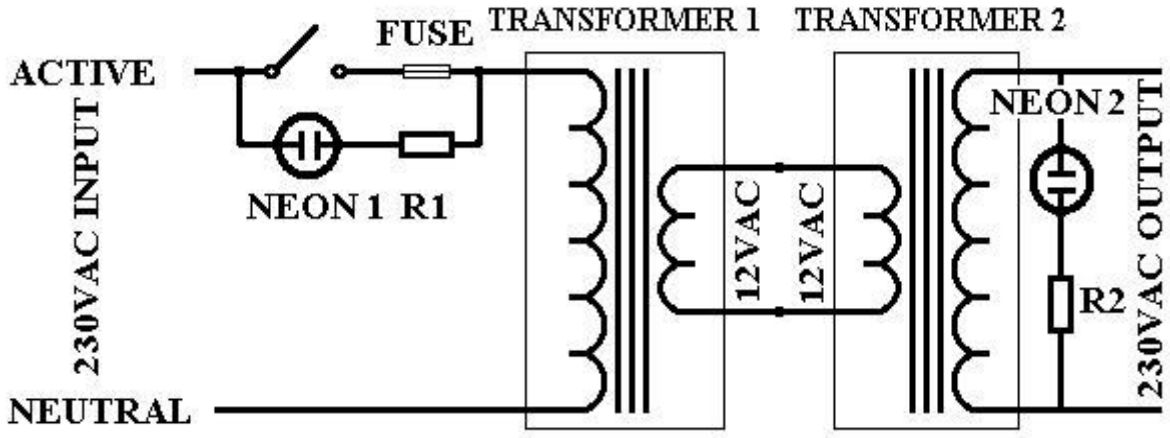
How is an Isolation Transformer constructed? Basically, it has a 230V winding on one side and a 230V winding on the other side, so the 230V coming out is isolated from the 230V going in. So how are we going to replicate this arrangement? We will use two identical UPS transformers and connect the low voltage windings back-to-back to achieve the same result. The illustration below left shows a conventional Isolation Transformer and below right is our version of an Isolation Transformer.



Left: A conventional Isolation Transformer. ***Right: Our Isolation Transformer.***

Now that we have established how we are going to make our Isolation Transformer, we can work out what parts are required. First, we need two identical transformers from old UPSs. These must be identical in order for the above arrangement to work correctly and produce the same voltage at the output as the input. Next, we need a power switch, a fuse, two neon indicators with 150K or 100K resistors and a case.

With all the parts on hand, it's just a matter of assembling everything and you will then have the equivalent of an Isolation Transformer. Usually, the UPS box that you got the transformer(s) from can be utilised for the project. It will already have the mounting arrangement for one transformer, so it should be relatively easy to mount the second transformer. The components are wired up as in the diagram below:



Above: This is how the transformers and other components are wired up.

How everything is connected

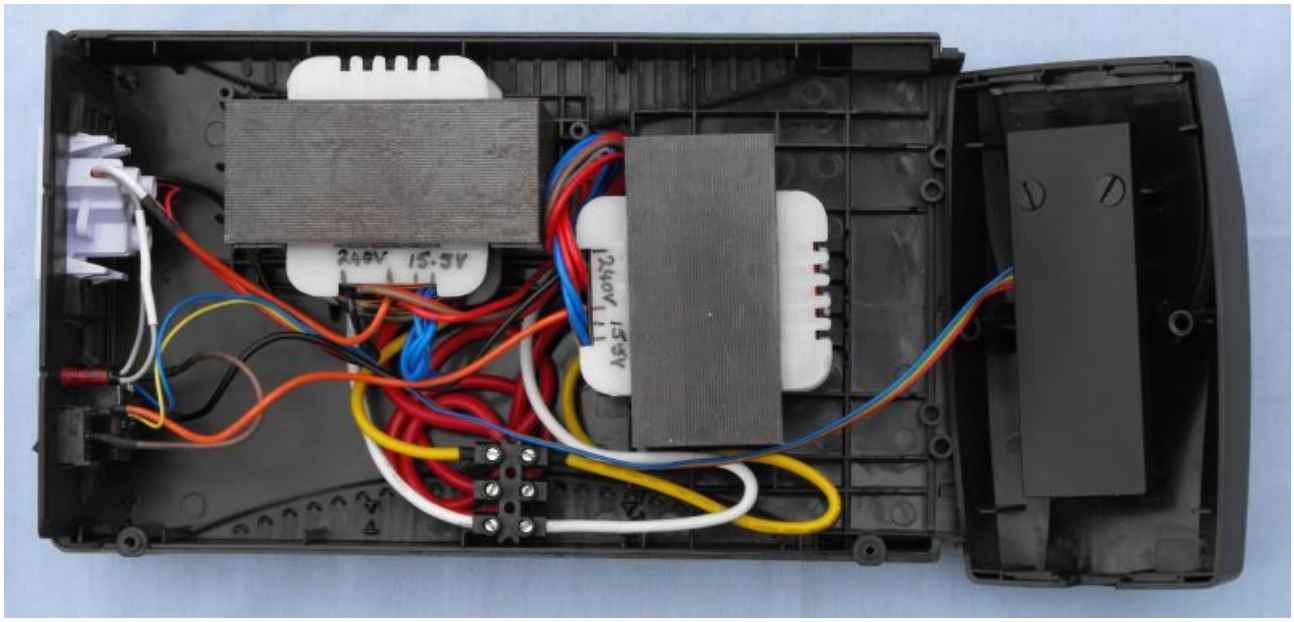
You may think that the wiring diagram for this unit looks rather strange, however, it shows the current state of the Isolation Transformer. With power connected and the power switch off, Neon 1 is lit (Standby). With the power switch on and the fuse blown, again Neon 1 is lit (Fault). With the power switch on and power at the output sockets, Neon 2 is lit, showing that the unit is functioning normally (Power On).

Assembling the unit

Now that you have a suitable case and you have been able to mount both transformers in the case, it's time to wire it all up. Follow the wiring diagram to make sure that everything works as expected. We used two 7V – 0 – 7V transformers. The centre-tap was not used, so these wires were coiled up out of the way. Due to the thickness of the wires on the secondaries, it was decided that the most practical way to connect them together was to use a heavy-duty terminal block as shown in the photo below.

The primary wires on the input transformer were soldered to the terminals on the power switch and IEC plug and heat-shrinked, while the wires on the output transformer were joined to the wires from the power socket on the back panel and soldered and heat-shrinked. This particular case had two power sockets and a fused IEC plug on the back of the case as well as two other holes. This arrangement did not suite our requirements, so it was necessary to make a new back panel for the case.

The picture below shows the arrangement with the UPS case and transformers that we used for this construction project. The small black cover on the back of the front panel was made to cover the PCB for safety, as it has pads at 230V potential. You may have a different case and different transformers to those shown below, but the same result will be achieved with careful selection of the parts to be used. Note that a new back panel was made from ABS plastic to replace the original back panel, as AS3000 clause 5.3.9.1 states that only one outlet is permitted on an isolation transformer.



Above: The layout inside the prototype Isolation Transformer.

The original case required some minor modifications to house the second transformer which was housed where the battery was originally located. As the transformer was thicker than the battery, the case had some of the ribs trimmed back by initially clipping them out with side-cutters and then finally trimming them level with a wood chisel. Be sure to wear safety glasses while performing this operation, or you might find yourself wearing a piece of plastic in your eye instead. Very unpleasant!

When using a steel case, it will most likely be easier to mount the second transformer on the base of the case, adjacent to the original transformer. We decided to use this small plastic case, as we had previously wrecked two of these units and therefore had two identical transformers that suited this particular case. Had we used transformers from a different case, then we would have utilised that particular case for the project. It's just a matter of using what you have on hand that best suits the purpose.

The case we used originally had three LEDs on the front panel. The top LED indicated Power On, the middle LED indicated Backup and the bottom LED indicated Fault. We removed the three LEDs and replaced the top and bottom LEDs with neon indicators and fitted appropriate resistors, in this case 150K, as these were miniature neons which replaced the previous 3mm LEDs.

The photos below show the Isolation Transformer in use. The left-hand photo shows the unit in standby mode or fault mode, while the right-hand photo shows the unit in operational mode.

Above Left: Unit in Standby or Fault Mode. ***Above Right: Operational Mode.***

The photo below shows the rear of the Isolation Transformer with the single power outlet, fused IEC plug, neon indicator and power switch. Note that AS3000 clause 5.3.9.1 states that the isolation transformer must have only one outlet and the earth pin of the outlet must not be connected to mains earth.

Above: The back panel of the Isolation Transformer showing the sockets & switch.

So there you have it. An Isolation Transformer for very little cost. Just wreck two identical dead UPSs and use the two transformers and a few other bits and pieces and one of the cases and you have an Isolation Transformer. In our case, we have a 460VA unit. That's a saving of over $200. Not bad for an afternoon's work in assembling the unit, as we had the required parts on hand from previous recycling exercises.

Using the Isolation Transformer

As stated earlier, the output from the Isolation Transformer is 230VAC, which is the same voltage as the mains input. This voltage can easily kill you if you happen to grab both wires at the same time. In this case, your safety switch will not protect you, because you are not connected directly to the mains.

This project is definitely for experienced constructors who know what they are doing with mains powered projects and who actually have a use for an Isolation Transformer. If you don't know how to use an isolation Transformer or if you don't have a use for one, then don't build one. The transformers used in this project would be better put to use for building power supplies that would be far more useful.