## Technical specification for a 3 pin plug

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Product</th>
<th>Analysis</th>
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</table>
| **Aesthetics**  
Why does the product look the way it does? | • The product is styled to provide a contemporary power unit for the home, office or work space.  
• The plug is a small unit with three pins inside it. The plug is shaped. The product is shaped in a certain way so that it can be carried around easily by the user. The plug is shaped in such a way that can be carried easily from room to room, wall unit to wall unit. | • The standard 3 pin plug fits into an English three pin wall socket. The plug itself comprises of a PVC (Polyvinyl chloride) casing which encloses a variety of wires and fuses to which it will insulate.  
• The product is not an ordinary cube- this makes the product more aesthetically pleasing in the modern home. |
| **Form and function**  
Why is the product shaped/styled as it is?  
What is the purpose of the product? | • The function of this product is to provide an electrical current from the wall socket to the electrical appliance. The current is provided through three brass pins conducting a charge from the power from the wall. The British Plug is 13A (13 Amp).  
• The product is shaped in such a way which is ergonomically viable- This means that the index finger and thumb can easily hold either side of the plug in moving around. The plug is generally is shaped in a hexagon, each edge is chamfered to promote safety.  
• The three pins include: earth pin, neutral pin and live pin. The pins are used to connect the wires in the cable of an electrical appliance with the wires of a minas socket supply.  
• Earth pin: This is used to conduct electricity safely away in case it becomes live.  
• Neutral pin: This pin carries the current back to the source  
• The Live pin: Alternates between the AC. It carries the source voltage phasing unit from the power grid via the electrical service panel. | • The form of the product is a plastic casing with a small hole on the under side for the wire to connect the plug and electrical appliance. The function is to store and insulate electrical components.  
• The function of a plug is the same regardless of the colour, shape or size: Transfer energy from the wall socket to the electrical appliance. |
| **User requirements**  
What qualities make the product attractive to potential users? | • The plug should enable the user to provide an electrical path from the wall socket to the appliance.  
• To be reasonably tough to prevent damage when dropped.  
• Prevent/ enable the user to fit the cable to the plug.  
• Be aesthetically pleasing and easy to grip.  
• Satisfy the British Standards. | • The user requires a smart, contemporary plug which is easy to handle when appliances are being transported.  
• Although the shape of the product does not affect the performance capability, some consumers may prefer a more “retro” design. |
| **Performance requirements**  
What are the technical considerations that must be achieved within the product? | • The plug should provide sufficient electrical charge to the appliance.  
• Provide a set of rigid pins for location in the socket.  
• Be resistant to the environment( Moisture/ Temperature)  
• Prevent an electrical current from the mains to the user.  
• Provide good electrical conductivity. | • The plug uses fairly basic electrical technology. The standard of manufacture will largely affect the quality of assembly- if one half of the casing is not accurately produced then the other half will not fit. |
| **Materials and components requirements.**  
How should materials and components perform within the product? | • Polyvinyl chloride, a type of plastic is used because it is relatively cheap, it can be easily moulded into complex shapes such as that of a plug. Plastic is a tough material so does not shatter when dropped. PVC also comes under the category of, foam plastics or Styrofoam.  
• The plug is made up of conductors. A conductor allows electricity to flow through it.  
• The pins are made of brass. Brass is an alloy of copper and zinc: The pins allow electricity to pass through them as they have conductive characteristics.  
• The fuse element including, fuse clips, cable wires and fuse ends are made of copper. Copper is malleable, so can be easily drawn into wires.  
• Many plastics are polymers of high molecular weight. Plastics can be, cast, pressed and extruded. | • PVC is a suitable material because it can be easily moulded to any shape. The material plastic can also insulate electricity so people cannot get an electric shock. Other materials include brass which is what the pins are made up of. The fuse element, fuse clip, cable wires and fuse ends are made of copper.  
• Plastic is a very basic material, the material is not highly pleasing to the eye yet insulates the electricity and keeps the wires hidden, a transparent material like glass will display the wires which is not aesthetically pleasing. |
| **Scale of production & cost.**  
How does the design allow for scale of production and what are the considerations in determining the costs? | • The plugs are produced in batch. They are under constant need due to the constant production of electrical products.  
When a product is produced in batch, the price for the  
Customer becomes cheaper: this is because the manufacturer orders the raw materials in batch which also reduces the price for the customer/ consumer.  
• Considerations in determining the costs include; what manufacturing process is going to be used, the scale of production.  
• There is mass intricacy involved in assembly of a plug.  
• Plugs are always in high demand from manufacturers as plugs are needed on all electrical appliances, which are also in continuous production. | • Plugs retail for under £1.00.  
• The production is cheap because they are manufactured in hundred of thousands- Due to the high demand.  
• Plugs are produced continually so rarely go, “out of stock”. |
### Comparing and Contrasting plug with similar product – Night light

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<tr>
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<tbody>
<tr>
<td><strong>Form and aesthetics</strong></td>
<td>Night light</td>
<td><em>The product is styled to provide the user with a small amount of lighting during the night. The product is modern and contemporary. The product unlike the standard plug is much easier to break. The product is much larger than a standard plug.</em></td>
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<tr>
<td></td>
<td>British, three pin plug</td>
<td><em>The product is styled to provide a contemporary power unit for the home, office or work space.</em></td>
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<td>Analysis</td>
<td><em>On balance the form of the plug is the same, yet the nightlight has an attachment of the light source of the back, this increases the depth of the product. The product is no longer a flat cube with a depth of approximately 2cm, it is more than double this, and there is no cable on the underside.</em></td>
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<tr>
<td><strong>Function</strong></td>
<td>Night light</td>
<td><em>The function of this product is to provide the user with a small amount of lighting during the night. The current for the light is provided through the brass pins conducting a charge of power from the wall. In contrast with a normal plug which just transports a charge from one appliance to another along a cable. There are however the three pins:</em></td>
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<td>British, three pin plug</td>
<td><em>The function of this product is to provide an electrical current from the wall socket to the electrical appliance. The current is provided through three brass pins conducting a charge from the power from the wall. The product is shaped in such a way which is ergonomically viable. This means that the index finger and thumb can easily hold either side of the plug in moving around. The three pins include: earth pin, neutral pin and live pin. The pins are used to connect the wires in the cable of an electrical appliance with the wires of a mains socket supply.</em></td>
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<td>Analysis</td>
<td><em>The plugs are produced in batch. They are under constant need due to the constant production of electrical products. When a product is produced in batch, the price for the Consumer becomes cheaper; this is because the manufacturer orders the raw materials in a large quantity to ensure that the production remains consistent. The main reason for the price difference is that, a standard plug requires very basic electronic technology, whereas a night light, requires more production time in order to attach the lighting.</em>*</td>
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<td><strong>User requirements</strong></td>
<td>Night light</td>
<td><em>The plug should enable the user to provide the user with a small amount of light.</em></td>
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<td>British, three pin plug</td>
<td><em>The plug should enable the user to provide an electrical path from the socket to the appliance.</em></td>
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<td>Analysis</td>
<td><em>The user requirements are most dissimilar, in the sense that each product has totally different intended outcomes: The nightlight provides the consumer with a small light source, whereas, the consumer of the electrical appliance requires the transfer of an electrical current, in order to operate their appliance.</em></td>
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<td><strong>Performance requirements</strong></td>
<td>Night light</td>
<td><em>The plug should provide sufficient electrical charge to emit light. The plug must fit flush to the wall unit.</em></td>
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<td>British, three pin plug</td>
<td><em>The plug should provide sufficient electrical charge to the appliance.</em></td>
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<td>Analysis</td>
<td><em>The performance requirements are the same, the plug is 13A regardless of the function it has to carry out.</em></td>
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<td><strong>Materials and components</strong></td>
<td>Night light</td>
<td><em>Polyvinyl chloride, a type of plastic is used because it is cheap, it can be easily moulded into complex shapes such as that of a plug. Plastic is not brittle so can be dropped onto a hard surface and still not shatter. Plastic is a tough material so does not shatter when dropped. Polyvinyl chloride will also be used for the slot in which the Perspex lava container fits inside.</em></td>
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<td>British, three pin plug</td>
<td><em>Polyvinyl chloride, a type of plastic is used because it is relatively cheap, it can be easily moulded into complex shapes such as that of a plug. Plastic is a tough material so does not shatter when dropped. PVC also comes under the category of foam plastics or Styrofoam.</em></td>
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<td>Analysis</td>
<td><em>The plug casing itself will be made out of PVC (Polyvinyl Chloride), however the added feature of the nightlight will contain other materials, for example: Lava night lights Require a, &quot;lava effect&quot; fluid. The plug will require a cable on the underside, which is not used for the night light.</em></td>
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<td><strong>Scale of production</strong></td>
<td>Night light</td>
<td><em>The plugs are produced in batch. They are under constant need due to the constant production of electrical products. When a product is produced in batch, the price for the Customer becomes cheaper; this is because the manufacturer orders the raw materials in large quantities to ensure that the production remains consistent. The main reason for the price difference is that, a standard plug requires very basic electronic technology, whereas a night light, requires more production time in order to attach the lighting.</em></td>
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<td>and cost</td>
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<td>customer/consumer. Considerations in determining the costs include: what manufacturing process is going to be used, the scale of production. There is mass intricacy involved in assembly of a plug. Plugs are always in high demand from manufacturers as plugs are needed on all electrical appliances, which are also in continuous production.</td>
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# Materials and Components used in a plug – Study of two main materials found in a plug

Would a different material do the same job? Would it be cheaper? Does a different material have some of the same characteristics?

<table>
<thead>
<tr>
<th>Component</th>
<th>Existing material and Why selected</th>
<th>Properties and Environmental Impact</th>
<th>Advantages of material.</th>
<th>Disadvantages of material.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Casing</td>
<td>Urea Formaldehyde-&lt;br&gt;• The material is strong&lt;br&gt;• Very poor conductor of heat and electricity&lt;br&gt;• Moulds well&lt;br&gt;• The material is a good electrical insulator. So electricity cannot pass through it.&lt;br&gt;• Once formed is a very stiff and hard material. Therefore it will not loose its shape easily&lt;br&gt;• The material is of a high quality, the material has various chemical properties which make it so distinct. There a diverse range of uses for this material</td>
<td>Polypropylene-&lt;br&gt;• This material is not a conductor of electricity. The material can be blow moulded to form complex shapes like the casing. The material is resistant to chemicals, can be vacuum formed and blow moulded. This is the linking of propene molecules. Uses include, house ware, textiles, artificial grass and carpets.&lt;br&gt;• High impact polystyrene-&lt;br&gt;• This material is not a conductor, similar to polypropylene, the material can be vacuum formed, blow moulded and extruded. When heated can be moulded, then sets when cooled. Polypropylene is one of the most widely used plastics. Uses include, foam cups, packaging and insulation, it is not bio-degradable.</td>
<td>Over 60 million tonnes of polypropylene are produced each year worldwide. Polythene is not considered as biodegradable because it takes centuries for it to breakdown. Polypropylene is impact resistant and can be easily joined and welded, it also has a good resistance to work fatigue. However it is considered as recyclable. Uses include, chemical resistant containers, hinges, bottle cracks and medical equipment. Polypropylene is naturally pale pink or creamy white in colour. Polypropylene is a thermoplastic and flexible. Polypropylene is not a conductor of electricity. Polypropylene is resistant to chemicals, flammable, can be welded. The material can be injection moulded (see above diagram). The material can be blow moulded, extruded, sliced, bent and vacuum formed. Waste material can be melted and reused in other moulds or rapid prototyping of new designs.</td>
<td>Tough, common plastic, good resistance to chemical contact, flexible, soft, electrical insulator, wide range of colours (Attract a wider client market). Provide a gloss or matte finish. Can be colourized to match product it is providing the charge to. Not biodegradable. Attracts dust. Brute. If the wrong amount of colour is applied to the material during the cooling process at the wrong time the finished material will susceptible to cracking.</td>
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<td>Pins</td>
<td>Brass. Composition- Cu and Zn in varying amounts. It has a melting point of 700-1000°C. The material is non ferrous, the hardness is intermediate as is the weight.&lt;br&gt;• The material can be soldered and brazed. The material can be cast, rolled, forged, machine cut, bent pressed and extruded.&lt;br&gt;• Note that there are other suitable alternatives for metallic conductors, however these are much more expensive. The best material is already being used, so it is not possible to find another.</td>
<td>Silver (Ag) is an excellent electrical conductor of heat and electricity behind Gold (Au). It can be alloyed with copper to improve strength and resistance. The use of an alloy also reduces the pitting rather than using one pure expensive material. The melting point of silver is 962°C. It is non ferrous, soft and has an intermediate weight. Silver can be soldered, welded, cast, rolled, forged, machined (cut), spun, bent, pressed and extruded. The material finishes well increasing the aesthetics.</td>
<td>The material is non-ferrous, is of medium hardness and weight. The material is ductile- meaning it can be easily drawn into wires for example. Its has a high melting point, if the plug is overused the copper components will not burn. Conductor of electricity and heat. Resistant to heat, wear and corrosion. Can be soldered. Can be brazed. Can be cast. Can be rolled. Can be forged. Can be machined/cut. Can be bent. Can be pressed. Can be extruded.</td>
<td>Ductile. The material is a good electrical conductor, it is malleable, easily machined by various processes, a good conductor of heat, it has the highest electrical and heat conductivity after silver (Ag). Scrap can be crushed, milled and used again. Brass can be reused for other products. Easily recycled. Brass is susceptible to cracking particularly in surroundings where ammonia is being released. Brass is not particularly hard- Which means it can be scratched or deformed in some way. Tarnishes in a damp environment which is bad for electrical connections.</td>
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<tr>
<td>Manufacturing Process</td>
<td>Description</td>
<td>Advantages</td>
<td>Disadvantages</td>
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| Compression Moulding   | • A combination of heat and pressure is used to change the material’s form and chemical structure.  
• Typical thermosetting plastics used in compression moulding are urea formaldehyde and phenol formaldehyde.  
• The moulds are made in two parts from high chromium steel (stainless).  
• Each part of the mould has an attached heater plate and the combination of mould plus heater is mounted on large heavy steel bases called platens.  
• In use, one platen is fixed to the bed of the machine and the other is moved by a hydraulic ram to close the mould and apply the pressure.  
• Typical operating temperatures are around 200°C and the force applied can range from 20 tonnes when producing small items such as bottle tops, to several hundred tonnes for larger mouldings  
• The mould is charged with a measured amount of powder or granules ready to be compressed.  
• Sometimes instead of being poured into the mould in powder form the plastic charge is first compacted into a shape called a preform. This is designed to fit easily into the mould cavity and is pre-heated so as to speed up the moulding process. When the two halves of the mould are brought together the plastic material is forced under compression to flow rapidly around the cavity.  
• The mould remains closed for two to three minutes with the heat from the platens causing the plastic to cure resulting in a permanent change in shape.  
• The main cavity is almost always the bottom half of the mould as this has to contain the material charge.  
• The top half of the mould (positive) is smaller than the cavity in the bottom mould (negative) by an amount equal to the wall thickness of the product. The two mould halves only touch at the pinch off point which is a ridge running around the cavity. When the thermosetting material flows around the cavity any excess can escape at this point. This remains attached to the product after it has been ejected from the mould and is called flash.  
• Flash is removed by tumbling the components in a deflashing machine.  
• Anti-static cloths are used to prevent the build up of electrical charge which would cause bits of broken flashing to stick to the components. | • The materials are different from thermoplastics as they cannot be reheated and reshaped because a chemical change, called polymerisation, has taken place.  
• Generally thermosets tend to be harder, stiffer and more resistant to the effects of heat and chemical attack than are thermoplastic materials.  
• Moulds are made using CAD/CAM so the design can be easily manipulated. The process is quick and cheap and wasted material can be re-used.  
• Tooling cost is typically less than injection moulding.  
• One piece construction (no welding or gluing part halves together.)  
• No cores allow for irregular shapes.  
• Seamless construction is ideal for liquid filled or airtight containers.  
• Excellent ESCR (Environmental Stress Crack Resistance.) | • Expensive equipment investment.  
• Running costs maybe high.  
• Parts must be designed with moulding consideration. |
| Injection moulding      | • Injection molding  
• (British English: molding) is a manufacturing process for producing parts from both thermoplastic and thermosetting plastic materials.  
• Molten plastic is injected at high pressure into a mould, which is the inverse of the product’s shape. | • High production rates.  
• Design flexibility.  
• Repeatability within tolerances.  
• Can process a wide range of materials.  
• Relatively low labour.  
• Little to no finishing of parts.  
• Minimum scrap losses. | • Expensive equipment investment.  
• Running costs maybe high.  
• Parts must be designed with moulding consideration. |
**Quality control**

In engineering and manufacturing, quality control and quality engineering are involved in developing systems to ensure products or services are designed and produced to meet or exceed customer requirements. These systems are often developed in conjunction with other business and engineering disciplines using a cross-functional approach.

**Quality assurance**

Quality assurance, or QA for short, refers to planned and systematic production processes that provide confidence in a product's suitability for its intended purpose. It is a set of activities intended to ensure that products (goods and/or services) satisfy customer requirements in a systematic, reliable fashion. QA cannot absolutely guarantee the production of quality products, unfortunately, but makes this more likely.

Two key principles characterise QA: "fit for purpose" (the product should be suitable for the intended purpose) and "right first time" (mistakes should be eliminated). QA includes regulation of the quality of raw materials, assemblies, products and components; services related to production; and management, production and inspection processes.

It is important to realize also that quality is determined by the intended users, clients or customers, not by society in general: it is not the same as 'expensive' or 'high quality'. Even lowly bottom-of-the-range goods can be considered quality items if they meet a market need.

*Source: Wikipedia*

**Quality control for electrical components**

Electronic components would be brought in to retailers warehouses in bulk. Engineers employed by the manufacturer would carry out tests to ensure the quality is of the desired standard and safe to use.

Testing of plugs would be vital, there are potential health and safety risks involved in electrical appliances, for example electric shocks. To reduce the likelihood of such injuries articulate test are carried out. Another specific quality check outside of the electrical side would be checking that the size of the casing is identical- obvious errors could occur, one side of the casing may be too small and wires may show causing a hazard- if this is the case then the product will not pass, “British Standards”

The testing engineers will look for dry joints which could prevent electrical current from flowing through circuit. Every five hundredth plug should be tested on electrical appliances. In order for a plug to work correctly and at its optimum capacity, all joints and fittings must be flush. If there is gap between fittings this suggests that it is not correctly assembled. Soak testing of final assemblies includes testing for overheating after excessive use.

**Quality control for the compression moulded casing**

The polypropylene pellets which would be used are sent to the factory. The pellets are checked against the manufacturers specification so that the correct grade and quantity are used and so that there is minimal waste. The process is regularly checked up on, the engineers responsible for checking the moulding will look for overheating in the system which would be a potential health risk and unwanted grit or particles which could affect the finished quality and how well the plugs sell. The plugs would be design using CAD (Computer aided design), and manufactured using CAM (Computer Aided Manufacture).

Both of these resources are calibrated so that the product is produced to a high standard and quality resulting in minimal waste.
Environmental impact

Materials

- Plastic is a relatively cheap material to buy, particularly in bulk sheets. Plastic can be melted if the product is not manufactured correctly, for example, when the plug shell is created and waste material is produced, this wasted material can be melted which can then be used again in blow moulding.
- Reusing plastic is preferable to recycling as it uses less energy and fewer resources. Long life, multi-trip plastics packaging has become more widespread in recent years, replacing less durable and single-trip alternatives, so reducing waste. For example, the major supermarkets have increased their use of returnable plastic crates for transport and display purposes.
- Conservation of non-renewable fossil fuels - Plastic production uses 8% of the world's oil production, 4% as feedstock and 4% during manufacture.
- Reduced consumption of energy.
- Reduced amounts of solid waste going to landfill.
- Reduced emissions of carbon-dioxide (CO₂), nitrogen-oxide (NO) and sulphur-dioxide (SO₂).
- Post-use plastic can be described as plastic material arising from products that have undergone a first full service life prior to being recovered. Households are the biggest source of plastic waste, but recycling household plastics presents a number of challenges.
- Mechanical recycling of plastics refers to processes which involve the melting, shredding or granulation of waste plastics. Plastics must be sorted prior to mechanical recycling. At the moment in the UK most sorting for mechanical recycling is done by trained staff who manually sorts the plastics into polymer type and/or colour.

- Materials can be either, renewable or non-renewable. Plastic falls into the category of non-renewable, because it is an alloy of non-renewable sources. Finite resources will eventually be exhausted.
- Many modern products made from non-renewable resources such as metals and plastics.
- The electrical energy used in their production comes from, coal, gas, oil or nuclear power.
- Reducing the amount of non-renewable materials in the product will lead to a cheaper product, and will save energy and waste.
- The aim for manufacturers is to make profit→ If it costs more to buy raw materials it will lead to the profit being less.
- In order for raw materials to become more readily available
  o The consumer must consider the purchase attraction.
- Reusing waste materials → Materials removed from the main source by wasting can be melted down and reused.
- Designing for easy product maintenance, so that parts can be replaced, without the need to dispose of the whole product at the end of its useful life.
  o Example: If the plug stops working, the fuse can be replaced rather than a whole new plug having to be purchased.

Manufacture

- Designing the product so that it can be recycled
- A lot of energy is wasted by electrical transfer from the wall socket to the plug- then from the plug to the appliance.
- Plugs are produced continually due to their constant need. Continuous production requires less energy in comparison with one off production.
- Sustainable resource management.
  Conservation→ The protection of the natural world in order to sustain the manufacturing industry.
  → Conservation is also concerned with the sensible management of resources and a reduction in the rate of consumption of non-renewable resources, such as coal, oil, Natural gas, ores and minerals.
- Efficient management of resources includes → Using less wasteful mining and quarrying methods.
  → Making more efficient use of energy in manufacturing
  → Reducing fuel consumption in continuous production.