Reverse Engineering Online Challenge - Dismantling of a Sky HD TV Box

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<u>Summary Report</u>

Over the last half-century, entertainment has been revolutionised in many ways. We went from simple games like ludo to huge cinemas with 45" screens. Our day-to-day lives have changed beyond comprehension. As well as this, we went from large and not portable, thick black and white screens to tiny handheld devices allowing you to have fun wherever you are, on the beach, in the train or even in the air! This change allowed technology to thrive and with it the world. Because of this important invention, people would consider this world that we live in as incredibly modern. However, in November of 1990, an extremely famous company, one that is sometimes referred to as the founders of modern technology, was founded. This company is Sky. The Sky box was introduced to the public in May of 2006, and it originally had only six channels, but it was a game changer. After this, it then slowly started to provide compatibility with Freeview (Satellite and Aerial) channels. Although many TVs already had Freeview support, there was no recording support and ability to watch the timetable of each channel. We chose this because of how it brought new ways of having fun, and the very start of Freeview channels. Lots of the many TV channels that people watch even today originated from this one Sky box model. This Sky model has been discontinued by Sky itself in 2016. This was because the box did not meet the demands at the time. The box was also very thick and heavy. Now, Sky has transitioned to a new box called Sky Q. The old box is still sold by other retailers and is still used by a large percent of the consumers, especially targeting the older people.

This Sky box included a chip which was able to manage video tasks properly, but not as good as the latest models we have currently. Sky+HD Box did not allow you to access the internet like some of the latest TV boxes do, but it did allow broadcasting of Sky Exclusive channels via Wi-Fi. Sky also manages everybody's subscriptions through a Sky viewing card. This viewing card contained the data of the user who used the box, and the box could only be used with the card.

There is also a recording function in this box, which many of the other TV box manufacturers did not include. This seems like normal features to us in 2023, but back in the day, around 10-20 years ago, these were very new features. Records were stored in the hard drive and could be accessed from a menu. The Sky box also contains buttons on the box itself, like wireless routers do. Did you know that Sky included a telephone landline port which was used for the Sky box to communicate back to Sky?

Our advanced technology around us now allows us to do all communication via the internet.

External View of Sky Box

Front View
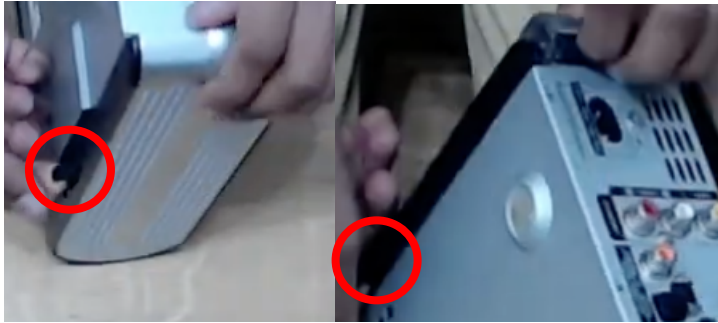

Back View

Side View

Bottom View

Dismantling Process

Step 1: Wear goggles to make sure that they are safe from any capacitors that may still hold a charge (was taken off in middle of process as they kept falling off)

Step 2: Remove the two screws indicated below in red circles

Step 3: Pull up the two clips indicated below in red circles and slide away the sides

Step 4: Pull the back centre clip and pull out the metal internal case gently.

Step 5: Use a plier to straighten the metal protecting the case from opening and bend the metal to remove the front buttons and top buttons.
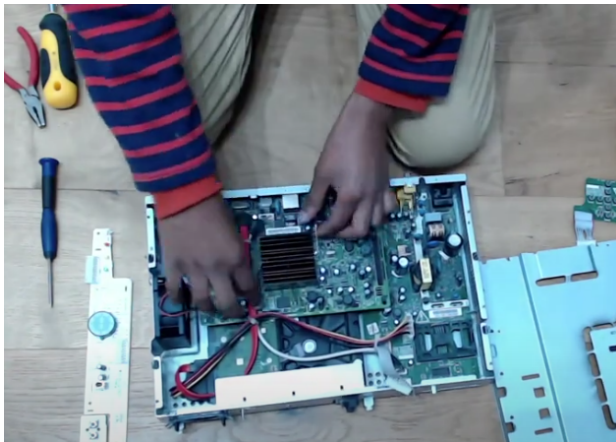

Step 6: Disconnect the front buttons and case buttons to be able to remove the top. Then remove the top cover.
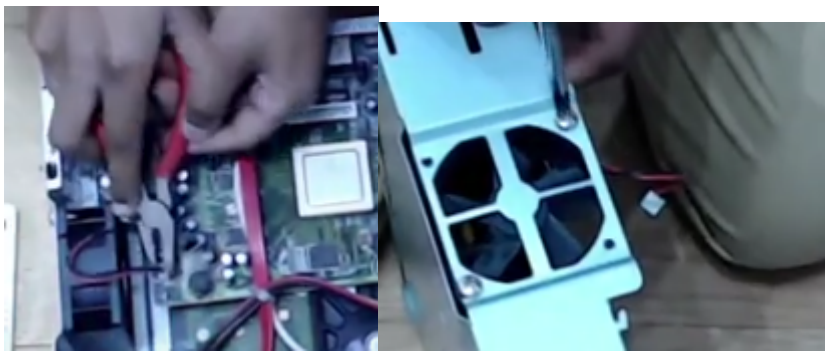
Step 7: Remove the heatsink with the clips.

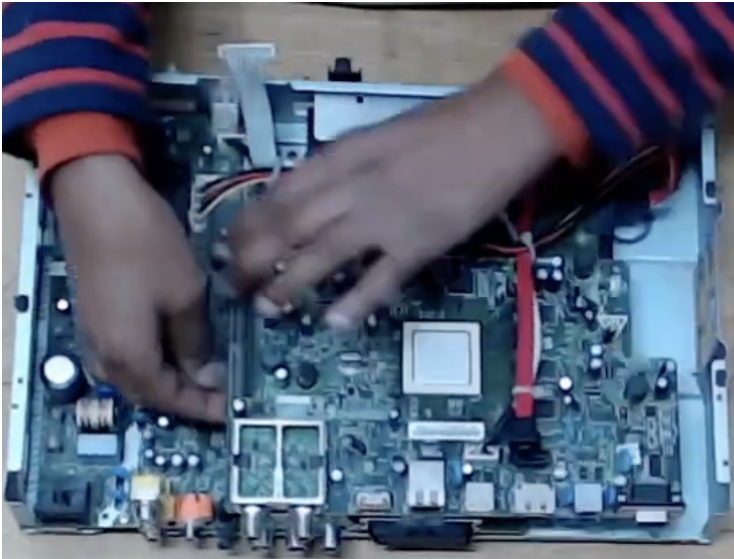**Step 8**: Remove the fan's connector from the motherboard and unscrew it from the side.

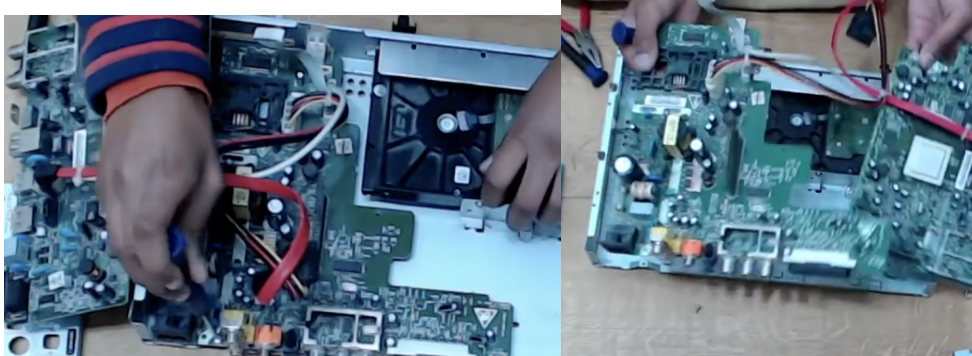**Step 9:** Remove the backplate to access the motherboard

Step 10: Remove the top motherboard (connected via GPIO)

Step 11: Remove the SATA cables that are connected to the hard drive

Step 12: Remove the lower motherboard with the screws.

Step 13: Remove the side screws and the clip screws to take out the hard drive.
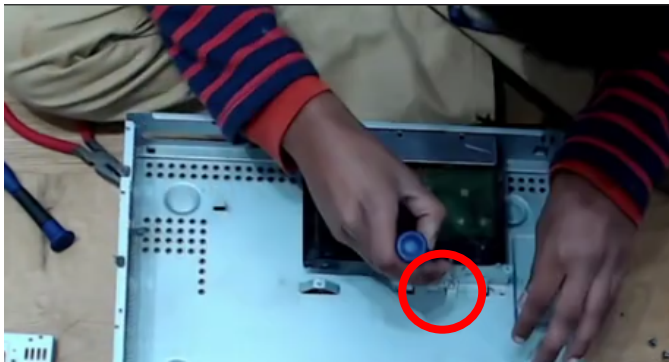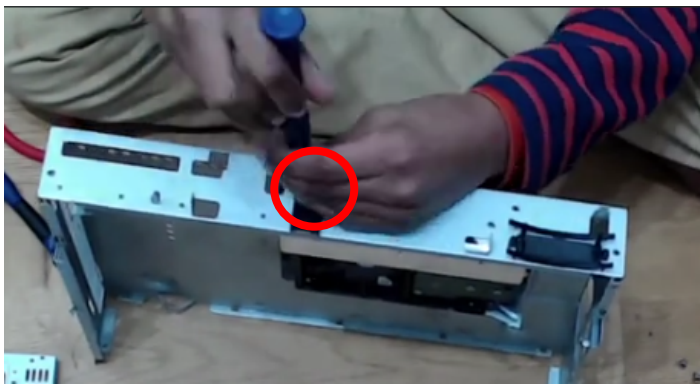
Step 14: Slide out the hard drive from the clip.

Dismantling process complete! Here's a video about the process:
https://youtu.be/WL5ln1XbKro

Parts

Casing

The black plastic casing around the metal interior has several purposes. For example, it allows ease of access to the control buttons at the front of the black, slightly rippled

casing. This is especially useful in scenarios where the remote controls are lost quite easily, like pubs and restaurants. It also looks much more aesthetically pleasing with a casing than with a bare metal box with an open fan, processor, and wiring. It is also plastic which means it is an insulator, meaning that it does not carry current. It looks like this:


Front LEDs and buttons

The front of the box has multiple uses from showing the LED indicators to controlling the playback of recorded files. Similarly, like the buttons to control the on, off and channels, this could be quite useful in many public spaces where the remote is not readily available. There is also a lid which protects the USB port and the port to input the Sky

viewing card. This is outlined below in the images of order in which they follow respectively: First is the plain front view of the Sky box, second is the view of the lid with the USB and Sky viewing card port, thirdly, the physical Sky viewing card and finally, the PCB of the LEDs and the buttons.
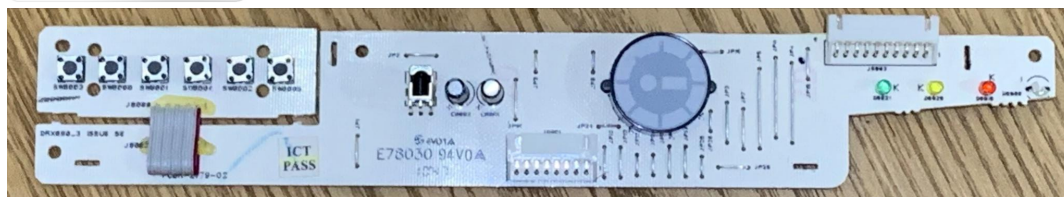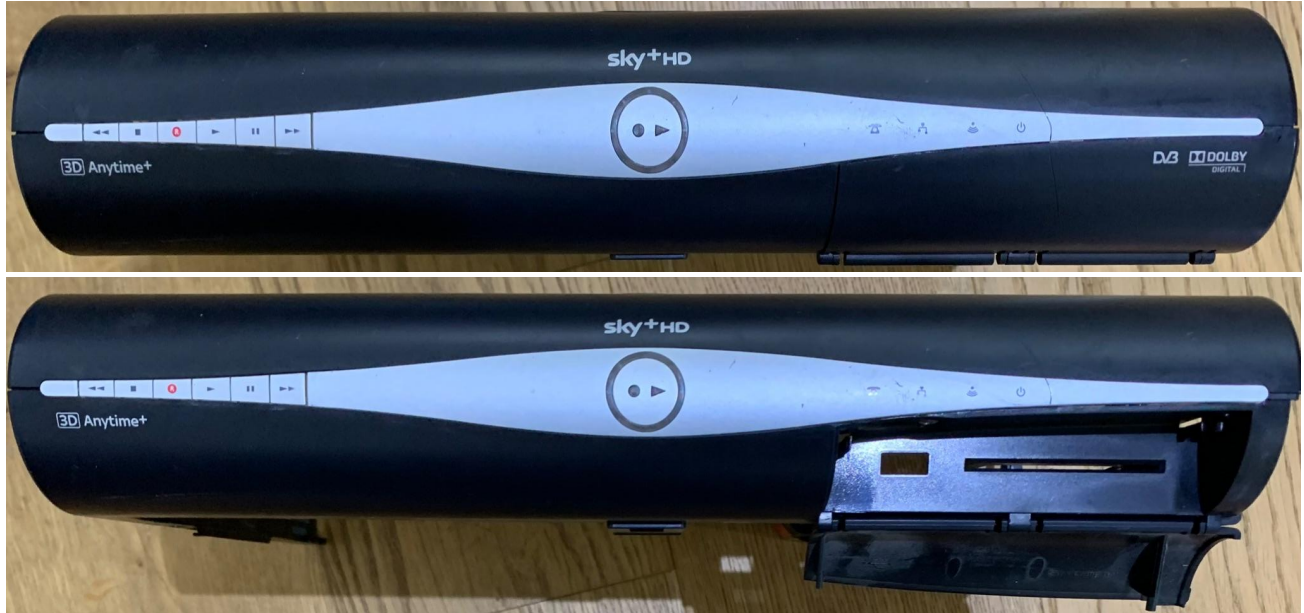
Ports

The box has many ports, from aerial ones to ethernet, as it was meant to be purchased by Sky users, many of whom have very old televisions. This meant that Sky had to give several ways for users to connect with their channels. The additional variety of ports allows people to add on many different components like speakers or Wi-Fi. These ports are situated on the back of the box to make it not the customer's direct view

Here is what it looks like:
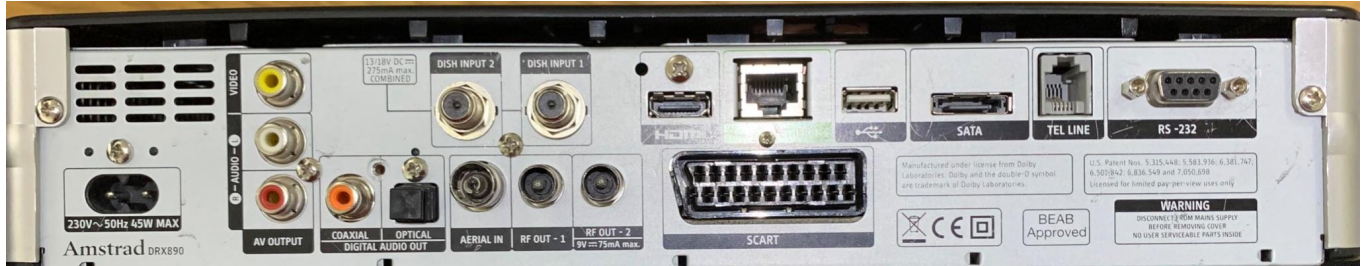
This is the empty plate in which the ports are inserted into:

Heat Sink

The heat sink is used to dissipate the heat from the chip during intensive work. It has thermal paste to stick to the chip to maximise heat conduction. The sink works by having a large surface area to transfer the heat to its surroundings, making sure the chip does not heat up too much. The 'spikes' on it are to increase its surface area and is black as the colour naturally absorbs and emits heat the best. The two hooks in the picture below both attach to the board to secure the sink in place:

Fan

The fan brings in air from the surroundings into the box to cool down the air if the heat sink is under lots of stress. It has rotors and leads directly to the outside of the box. It is secured onto the main body by screws. It has a varying number of fan blades, which are also called paddles, impellers, or rotors. In an electrical device, fans are used to draw cooler air into the case from the outside, expel warm air from inside and move air across a heatsink to cool an area or component. They work by pulling in air, causing a low pressure, which is automatically filled in by air around it. This creates a flow of air, which will continue to flow if the fan blades are still moving. As the cold air flows in, it is heated up and displaces the now-warm air inside, which we can tell by putting our hand near the fan. Most likely, there will be a flow of warm air coming from the fan.


Hard Drive

The hard drive is where the box downloads what you are viewing, converting a digital signal to an analogue one. It is also used to save recorded programs to watch for later. Our box has 500 gigabytes of storage, approximately 360 hours of SD TV. The data is stored in binary, a language that computers use that only has 0s and 1s. These numbers are stored on a magnetic film and are read by 'heads' that float due to the air that pushes them up from the extreme rotational speed of the film. This is known as an HDD (Hard Disk Drive), and it is much slower than the modern-day SSDs (Solid State Drive) because SSDs don't require moving parts to function whereas the HDD has a moving platter. This hard drive has a whopping 5900 RPM (Rotations per minute) compared to most 2.5-inch hard drives, which usually have 5400 RPM. The hard drive is quite large compared to the SSDs we use, which is, on average, only 2.5 inches because the 3.5-inch HDD requires more power to function with a device. The 2.5-inch

HDDs are usable for numerous devices, but they are slower than a 3.5 inch. Here is the hard drive we found in the Sky box:

Motherboard (Top & Bottom)

In the Sky box, we found two motherboards connected via soldered GPIO (General-Purpose Input/Output) pins, indicated by the arrow, which we later managed to identify as boards for two different purposes. The image is linked below:
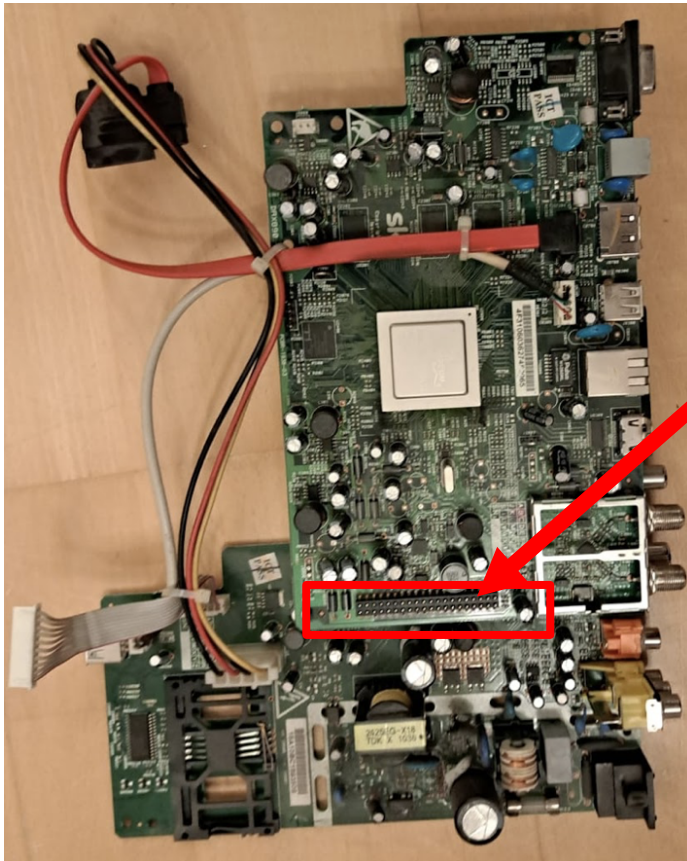
GPIO Pins

Judging by the various parts inside the motherboard, we found out that the lower motherboard managed the power, older tv connection ports (SCART AV) and aerial connections. However, the top motherboard was found to manage the data transfer between the device (including the hard drive and ethernet), satellite connections and newer TV connection ports (HDMI, VGA).

Analysis of the Top Motherboard

The CPU

If looked closely at, we can see that this is a Broadcom CPU, which was protected by a heatsink which was removed during the reverse engineering process. CPUs (Central Processing Units) can get very hot during resource intensive work, so to prevent frying the CPU, you need a good cooling system.

The transistors, capacitors, and resistors

Next to the CPU, there are multiple soldered parts, and they all perform a very important job. They all work together to make sure that the CPU does not fry by also receiving too much current and distributing it evenly across the other parts. Here's a picture:
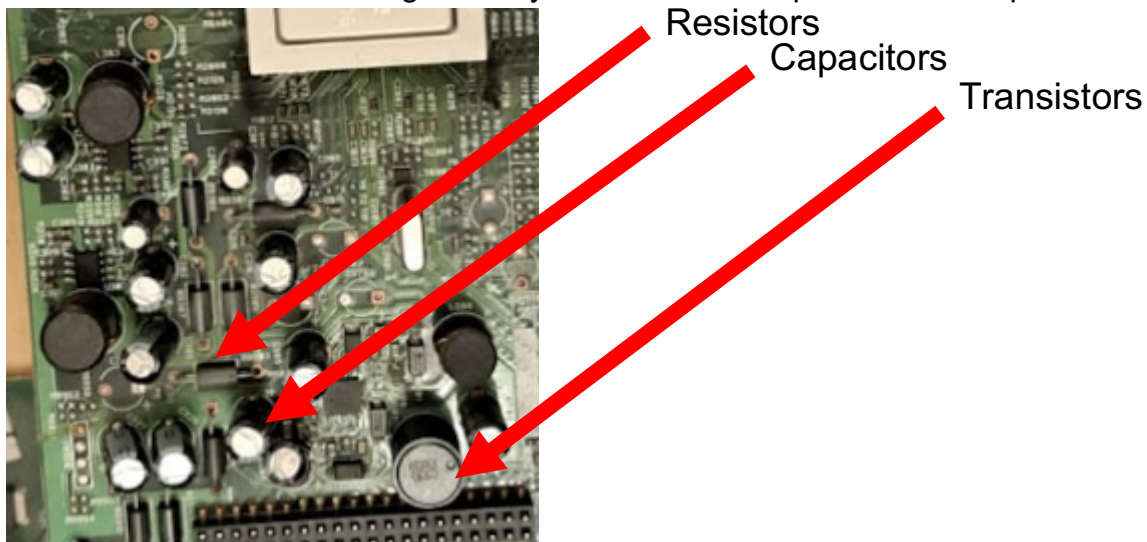
The silver shiny cylinders are called capacitors. They make sure that if there is too much electricity, that they capture the electricity and store it for a while, before releasing it rapidly. Without these, the current may overflow the board, making the CPU reach temperatures which can melt the motherboard.

The larger black cylinders are called transistors. They act like a gate which gives out power only when the components require it. These produce a significant function in starting and stopping specific functions at automated times.

The flat black cylinder connected to the motherboard with copper wire is the resistor. This is not a normal resistor, with the colour bands, but it is used for the same function. It is used to limit the amount of current passing through the motherboard.

The chips used to transfer data between ports

In the image below, there are more capacitors, transistors, and resistors, but there are also a few chips which do a function of transferring and converting analogue to digital signals from the ports.

However, the 3 chips which are under the red cable do a job of connecting the data from the hard drive to the motherboard.

Analysis of the Lower Motherboard

The Power Circuit

This device has a power port which is sourced at a 230V~50Hz 45W maximum voltage and wattage. But this huge amount of power cannot go to one component alone, it must power the whole board, and all the board transistors help channelize the power to specific parts, making a functioning device. Here's a picture of the circuit:

As you can see, there are much larger capacitors, which means that more energy will be stored.

The Hard Drive Cables and Connections

There was a thick red cable with a shorter end connecting from the top motherboard to the place where the hard drive would have been (image attached below for reference).
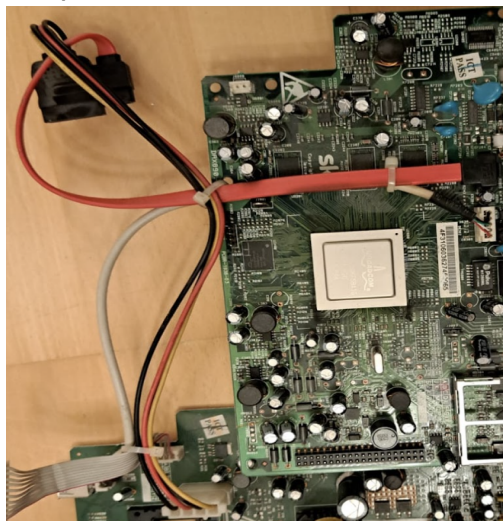
But what about the cable with the bigger end with four mini cables inside it? What does it do? The thick red cable is called a SATA cable, and it is used to access the data on the hard drive. The bigger cable connecting to the lower motherboard is a power cable which powers the hard drive with 12V. The reason why there are 2 cables connecting to the hard drive unlike 2.5-inch hard drives is because 3.5-inch hard drives require more power, making them faster. The lower motherboard, as stated powers up the component (in this case, the hard drive) and the top motherboard accesses the data and produces an output which can be accessed from the display.

Card Reader (Sky viewing card)

The Sky HD Box comes with a Sky viewing card as mentioned above and on the lower motherboard, there is a USB power port and a Sky viewing card reader. The reader reads the subscription number and activates the Sky box. Usually, the card is never removed, unless there is an issue. The Sky card reader and USB port are protected by a hatch door on the front. Here's a picture of the reader on the motherboard and a picture of the card and USB slot:

<u>Conclusion</u>

In conclusion, we believe that we have learned a lot of things by disassembling this Sky box as it includes most of the components that are included in a computer. We have also learnt the basic requirements a product needs to function correctly. For example,

some of us didn't know a hard drive had moving parts before we completed this challenge.

<u>Bibliography</u>

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https://www.youtube.com/watch?v=nQIB5qcl3R8

<u>Credits</u>

Shravan: Writer of the document and made video
Nitesh: Helped with dismantling process steps
Shrey: Helped writing summary report and proof-read
Arhan: Helped writing summary report
Kavin: Research into parts
Dev: Research into parts