HOT SPOT

Compiled by:
BBGSPORTS
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For the ICC only.
BACKGROUND

The ‘Hot Spot’ is an Infrared Thermal Imaging camera. It sees images and represents them as a temperature. In the “Hot Spots” case, black = ‘cold’, white = ‘hot’. It provides a reliable source of information that is not always available to the human eye, which when paired with broadcast cameras allows us to get closer to more correct decisions.

Images can be difficult to interpret accurately when based upon certain objects, specifically objects with erratic temperatures.

Sun, temperature, reflections, backgrounds all differ from venue to venue. It CAN affect the ‘Hot Spot’ image. These natural occurrences can make it difficult to detect a ‘fine nick’. We are all striving for consistency in the interpretation of images.

The more time spent viewing infrared, the more understanding you will have of the technology and its benefits and limitations. Our operators are happy to show clips and explain what is occurring in the images.

There are 15 videos to assist in the understandings of this document:

If they are highlighted in Red – 1st GENERATION CAMERAS
Yellow – 2nd GENERATION CAMERAS
CAMERA POSITIONS
SIDE ON CAMERAS

We get the best results where possible to be at ground level.

Side on cameras will be 2\textsuperscript{nd} Generation cameras wherever possible*. (*We only have 2) It is worth noting we do use local people from each venue to man our cameras in moving them from end to end at the completion of each over. The viewfinder monitors are very low spec and cannot be used for analyzing the vision. The analyzing of the Hot Spot images occurs in the OB truck where it is conveyed to the director.

We have had trouble with camera positions blocking signage and hover crafts, where we are more than happy to compromise. Our operators are very experienced though we have not done cricket in all of the venues currently used by the ICC.

FRONT ON CAMERAS

Our cameras are always within 60cm of the skyline LBW cameras. They are locked off on the crease line at each end, therefore in an ideal broadcast we have 3 angles available, as one will be set on the other end of the pitch.
1st GEN CAMERAS VS. 2nd GEN CAMERAS

We have 2 x 2nd Generation cameras called HAWKS

We have 6 x 1st Generation cameras, used for front on 'Hot Spot'

All cameras have a frame rate of 92-106 frames per second.
The only differences are:

**Integration time:**
Motion blurring, noticeable on fast moving objects (ball, fast swinging bat)

- 2nd GEN cameras have .5 milliseconds, 1 milliseconds, 2 milliseconds.
- 1st GEN cameras can get down to 3-5 milliseconds in perfect seeing conditions (sunny day 13-32C).

It is hard to pick up the line of the ball moving through the image in 1st GENERATION cameras.

**Zooming:**
Getting the perfect head to toe shot of the batsman.

- 1st GEN cameras have a turret 3-lens range, that can severely restrict 'Hot Spot' when distance from the boundary to pitch is under 70 meters. (this can be particularly difficult when having to use 1st Gen cameras side on)

refer: [ICC video 7](#)

- 2nd GEN cameras can be zoomed to any distance needed on a cricket field, to get a perfect head to toe shot.

We will still be using the 1st Generation cameras for front on Hot Spot when required by the broadcaster, usually only Australia and the UK. Where they require a more complete 4-camera system (instead of the 2-camera setup).

We have found the front on cameras extremely useful mainly for bat-pad decisions and the jamming of bat onto pad. Having 4 cameras covers more bases and provides more evidence to achieve the right decision with a high degree of confidence. As there will be 3 hot spot angles on each ball.

We can zoom up to 200% of the original image, however some quality will be lost.

Our operators will zoom images to best convey the information required. 3rd umpires can also ask for zooming during the DRS process.
CAMERA ANGLES

We listen to 3rd umpire so they can direct us to angles they want to see. Our Front on cameras are unmanned, so they are locked off at the start of the game on the batsman’s crease.

FRONT ON CAMERA  1st GENERATION CAMERA
Bat flicking pad mark shows where the 2nd noise comes from
VIEWING HOT SPOT

- Find the ball moving through the picture. Rock and Roll.

- Watch for the line the ball moves through the picture, you can ask for longer lead in time.

- Be aware of where the ball is passing the bat, i.e. Height.

- Ask for a longer lead in time so the line of the ball can be established.

- Take note of any “marks” on the bat that are not caused by friction, prior to the ball arriving to the bat.

- When necessary, view both sides (OFF and ON side) also Front on to get a better understanding of the incident. It will give you a better idea of the incident. 2 noises heard, find where they came from.

Refer:
ICC video 15 2nd GEN side on(with a 1st Gen Front on angle)

- To be sure the mark is made from the ball-hitting bat, ask to see a couple of frames past the point of contact. Though it may be so fine it only stays for a few frames, or until the bat rolls out of shot.

Refer:
ICC video 5
DECISION MAKING

There has been pressure from all levels of cricket to get decisions right. Some stray away from the process and allow an element of “guess” work to come into the decision making in order to be seen as making the correct decision. There has to be conclusive evidence that an error was made – Hot Spot has a role in this.

WHEN THERE IS A MARK?
Confirm that the mark wasn’t there before the ball arrived. For example, the view of an inside edge may be blocked by something. Be aware of which area the ball passes the bat and whether the mark lines up to where the ball passed the bat.

It is worth noting that when a ball hits something “FLUSH” it will rarely leave a mark, as there is little friction on impact. Similar to rubbing your hands together the friction makes them warm.

CONTRAST LEVELS DIFFER DUE TO THE AMOUNT OF HEAT IN THE PICTURE.
It may require an image to appear bright, in order to best show the edge. BBG has software in place to set these light and darkness settings in order to best show the heat marks. These can vary due to the position of the sun depending on the camera angle.

Marks can be hidden by solar flare or an angle that is not covered by our cameras. These areas include top edges and under edges, particularly when a batsman is sweeping. They may not show up until the bat edges rolls into view of one of our cameras.
EXAMPLES of HOT SPOT marks:

BAT ON BALL

Smith, ADELAIDE 2012, 1st innings DRS

74.2 Siddle to Smith, OUT, Huge wicket, Smith's called for a review, pitched on a good length outside off and Smith tried to close the face on that one and drive it in the region of midwicket, there was a deviation, but the bat appeared to hit the ground just as the ball went past the bat. Bowden's given him out caught-behind. Did it move away just as the bat came down? Hot Spot shows a tiny heat signature on the outside edge, a very tiny one but it's there nevertheless. Bowden's waiting for the final call, and raises his finger. Smith isn't happy, he called for a review immediately after Bowden first gave him out

GC Smith c †Wade b Siddle 122 (295m 244b 14x4 0x6) SR: 50.00
BATSMAN NOT FEELING AN EDGE

We have seen many examples of it, or are they trying their luck?

Swann (Trent Bridge 2012, 2nd innings DRS)

Refer:
ICC video 3
BALL ON GLOVE

Can be the most difficult to spot. But rock and rolling the frame before the ball arrives and the frames after will confirm or deny conclusive evidence.

Here is an example of a 1st Generation camera detecting contact with the glove.

Refer:
ICC video 11

Here is an example of needing to view both the “on” and “off” sides when looking for conclusive evidence on Hotspot

Refer:
ICC video 12

Here is a tiny mark that is only visible for 2 frames. This would be a good example to zoom, if our operator has not already done so (the example provided is not zoomed in). Matching the area where the Hot Spot shows a temperature change to a Super Slow Motion or Ultra Motion camera replay will allow you to be conclusive that the mark on the glove was caused by the ball.
BAT ON GROUND

Taylor/Trott scrapping their bat on ground leaves white mark on the toe of their bat, which can stay long into an over.

If the edge come from the toe it will be hard to detect due to the rough surface of a bats toe coming into contact with the ball.

Constant scrapping still shows a heat mark whilst playing a ball
BAT ON PAD

The ball passes the inside edge, the bat on pad mark looks like an edge. But if you follow the line of the ball there is no way the ball made that mark on the bat, on viewing the OFFSIDE you can see a tiny mark where the bottom edge of the bat flicked the pad. You can also see the effect of the sun on either side of the infrared pictures.

This is where viewing both angles is a must. To determine where the 2\textsuperscript{nd} noise has come from.

OFFSIDE EDGE

INSIDE EDGE
PAD BEFORE BAT

Look for what the ball could have done, if you are only for an edge on Hot Spot you might miss something like the ball scraping the pad.

BALL ON CLOTHING - will rarely show a mark as the player’s shirts are designed with artificial fibers to breathe.
BLOCKING EXAMPLES

There can be varying degrees of blocking we will always show all sides if needed.

The blocking can occur from close in fielders or fielders on the boundary.

This is due to our need to be relatively level with the playing ground

HOBART 2011

This is the Jessie Ryder on side angle that never went to air, but showed nothing as the bat rolled over by the time it was past the in close fielder.

BROADCAST VIDEO included.

2.6 Pattinson to Ryder, OUT, appeal for lbw. Clarke has called for a review, swung in and rapped Ryder on the pads near leg stump, the bat made contact with the pad as Ryder was trying to close the face on that fullish delivery. Hot Spot left the mark but to me it seems it was the bat making contact with the pad and not the inside edge but it's what the umpire thinks that counts. Ball-tracking shows the impact was in line with the stumps and the ball would have gone on to hit leg stump. Nigel Llong reverses his decision, it's out and Ryder has to walk back.

http://www.espncricinfo.com/australia-v-new-zealand-2011/engine/match/518948.html?batsman=44946;innings=1;view=commentary

refer:

ICC video 4
WHEN THERE ISN’T A MARK?

There are still circumstances where a Hot Spot will not show up. Infrared is a science that we will continue to learn about. BBG Sports will continue to improve the Hot Spot in order to arrive at conclusive evidence.

Here are some external influences that can affect our ability to see in infrared.

SUN GLARE
We have trouble finding edges on the angled bat shots. Due to less friction and also the sun reflection. The sun reflection is greater with plastics on the bat, hiding the impact point of ball passing bat.


This can also leave an area of the bat in shade, so it will appear darker and can make it hard to spot marks on the bat, especially when the batsmen is swinging hard at the ball.
Again the ball passes the front edge of the bat, Agar is swinging hard. The Real Time Snicko suggests that the noise occurred as the ball passed the bat. Hot Spot might have missed this one.
**SOLAR FLARE**

You can see the sun glare on the gloves before the ball has arrived. Making it near impossible to be confident in evidence from Hot Spot. INCONCLUSIVE

DC Thomas, 2013 Perth

29.4 141.5 kph, gets a short ball on off stump which goes past the outside edge as the batsman tries to sway away. Everyone goes up on an appeal for caught behind. the umpire shakes his head, but they call for a **review**. A brute of a delivery. Hot-spot being tested. Was there some glove on it? Not sure...hot-spot not very conclusive... They are checking for sound cues... too long being taken here (we are into the zone where DRS starts becoming a bit of a pain). He gives him out.. on the sound cue.. Well, I thought ..Speechless I am.. 166/6


Refer:

[ICC video 1](http://www.espncricinfo.com/australia-v-west-indies-2013/engine/match/573023.html)
**SEAM VS. SPIN**
Which part of the ball that comes into contact with the bat can create more or less friction. If the seam scraps the bat a bigger heat signature is more likely to appear, than if the leather does. As the seam is generally more abrasive creating more friction, in turn a stronger heat signature.

**SWINGING HARD**
This is a problem when using 1st GENERATION cameras. These cameras cannot operate at the same specifications as our 2nd GENERATION cameras. Best shown on page 3.

When the bat is moving quickly through the image the blurring can mask fine edges and makes it harder to see.

The Sangakkarra (Sri Lanka) video from Cardiff 2011 although a 1st GEN camera shows the stickers masking the edge, given not out and review was upheld. Refer:

[ICC video 2]

It is also harder to find the Ball moving through the image on 1st GENERATION cameras.

It is worth noting that the sensitivity in perfect conditions of 1st GEN to 2nd GEN cameras is the same. Meaning that if a ball were to flick a pad that is static (batsman’s foot planted) the heat signature would be the same on 1st GEN and 2nd GEN.

Refer:

[ICC video 8]

**BAT MARKINGS**
Stickers and branded edges can make finding a Hot Spot more difficult than it should be.
OUT OF FRAME

Very rarely a batsman can play a shot and due to the framing of our camera, we may miss the bat on ball frame. Again this only should effects 1st GENERATION cameras as they cannot be zoomed to suit the varying boundary lengths.

Though our local camera helpers do not follow the batsman down the wicket if they decide to dance down the wicket, we prefer the camera to be stabile at the point of contact.
Refer:
ICC video 7

GLOVES

Plastics and soft materials can make it hard for a heat signature to be transferred to the protective material. It is more likely to pick up a brush of the gloves than stronger contact. Usually this is covered by Super Slo Motion and Ultra motion cameras showing the gloves being disturbed.

Plastics reflect the sun similar to looking directly at the sun, masking the image until the reflection has past.

Refer:
ICC video 6

EXTREME HEAT

In climates exceeding 33C temperature, it can make it harder to detect changes in temperature on the edge of wooden bats, due to the ball and the bats being warmer. Also the background heat can affect the image contrast levels, making the Hot Spot image seem extremely bright.

Refer:
ICC video 9

There is no mark that showed up on Hot Spot. These front edges are where we seem to get most of our problems. The batsman was given out on noise.

ICC video 13

A small conclusive mark on the back edge of the bat is shown on Hot Spot. Batsman given out on Review.
EXTREME COLD

Extremely cold, overcast below 13C temperatures particularly in the UK venues can affect the quality of the image coming from the cameras, as there is less heat to focus on. It can make the image seem grainier and dark.

Refer:
ICC video 10

Follow the line of the ball into the bat, and if there is a mark appearing on the bat ask to see a frame after the initial impact to make sure that the mark is still there. (This may not always be possible due to the bat ‘rolling’ out of shot). This example shows the ball hitting both pads, accounting for the 2 noises.
**PREMATCH PROTOCOL**

Umpires can seek out Hot Spot operators before the game to ask them of any things to note. Camera positions will be resolved with the Production Manager and ground staff. There can be issues with getting our cameras on ground level at some venues. There might be a hovercraft that will need direct access to the pitch (Edgbaston).

Other things to note might be extreme weather conditions however the impact of these we haven’t been able to calculate.

Umpires spending a day in the truck. Sitting with the people who deliver the technology for the DRS process. Gaining the experience of being ‘on site’. The more ‘Hot Spot’, Super Slo Motion replays, LBW tracks you see the more likely you are going to know what to look for.

Difficult scenarios in the past have been misrepresented by commentators and umpires alike. On a number of occasions commentators have used Hot Spot vision and used a telestrator to indicate contact, which our operators have concluded as being completely wrong. They do not always take our opinions on what happened.