

# Thermal Imaging



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How Thermal Imaging works

The Flir E6 Camera

Building Diagnostics

The software

Borrowing the Camera



Source: FLIR



heritage  
foundation  
Letchworth Garden City

The community thermal imaging service has been funded by a grant from the Letchworth Garden City Heritage Foundation

# The Flir E6 Camera



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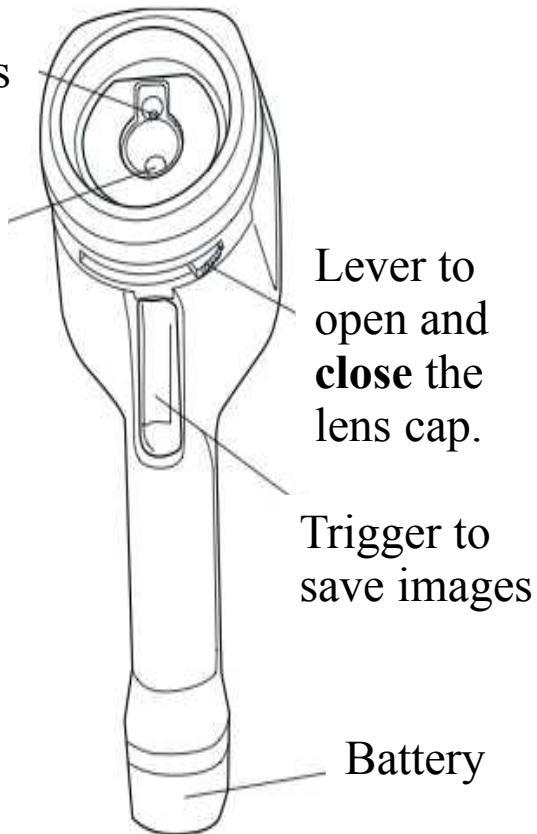
To get started:

Push the On/off button to turn on the camera.

Open the lens cap by pushing the lens cap lever!

Digital  
camera lens

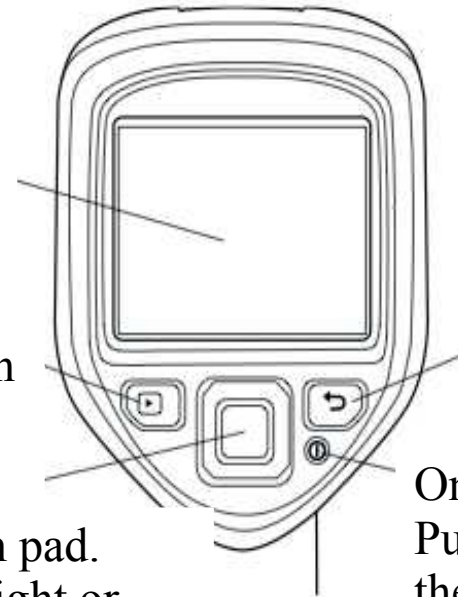
Infrared  
lens



Camera  
Screen

Archive button.  
Push to open the  
image archive. Push  
again to return to  
live mode.

Navigation pad.  
Push left/right or  
up/down to navigate  
in menus, submenus  
and dialog boxes.  
Push the centre to  
confirm.



push to cancel a  
choice or to go  
back in the  
menu system.

On/off button.  
Push to turn on  
the camera. Push  
and hold for more  
than 1 second to  
turn off the  
camera.

The camera is focus free (focus is set and cannot be changed). **(Keep at least 0.5 metres from object to focus)**

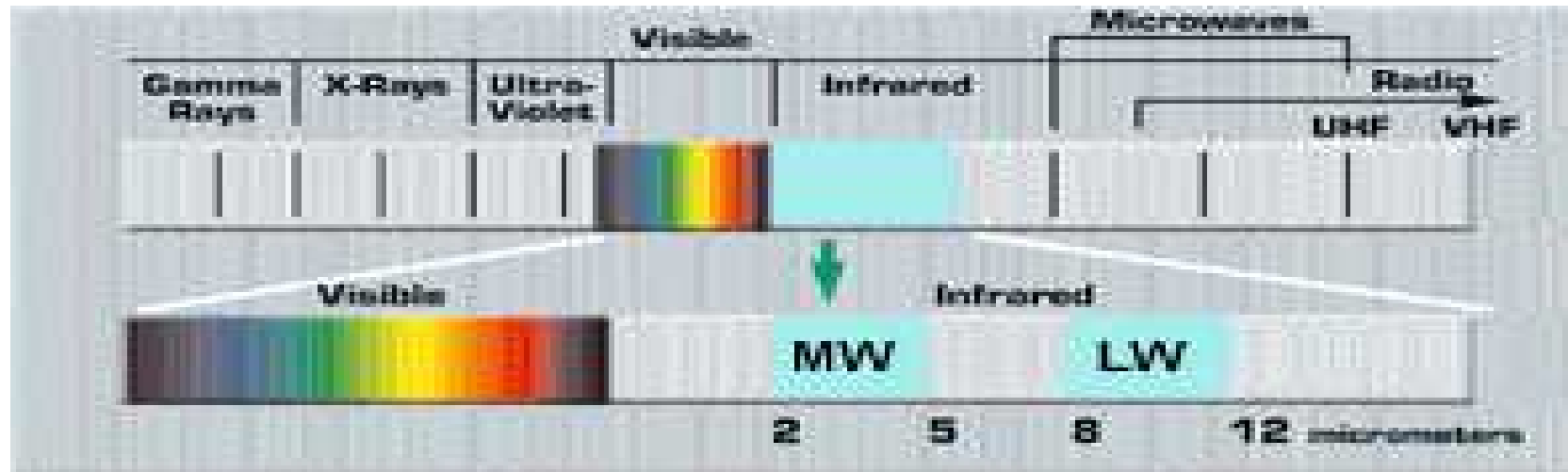
Up to 500 images can be saved.  
Image names will be the next in the xxxx  
sequence of FLIRxxxx.jpg

# Thermal Imaging



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## The Electro-magnetic Spectrum



- Thermal Energy is non visible light – its wavelength is too long for the human eye to see
- Humans perceive this energy as heat,
- Everything with a temperature above absolute zero emits heat, even very cold objects like ice.
- The higher the temperature of an object the more IR radiation is emitted.
- Infrared camera's measure the radiation and produce an image of the heat of an object - they will not show air temperature.

A thermogram is a true image of radiation, it may not be an accurate measure of temperature. For building diagnostics thermal images are analysed to determine where a temperature difference exists, not exact temperature differences.

# Thermal Imaging



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Every pixel in the radiometric image is a temperature measurement.

Darker colour means cooler, brighter means warmer.



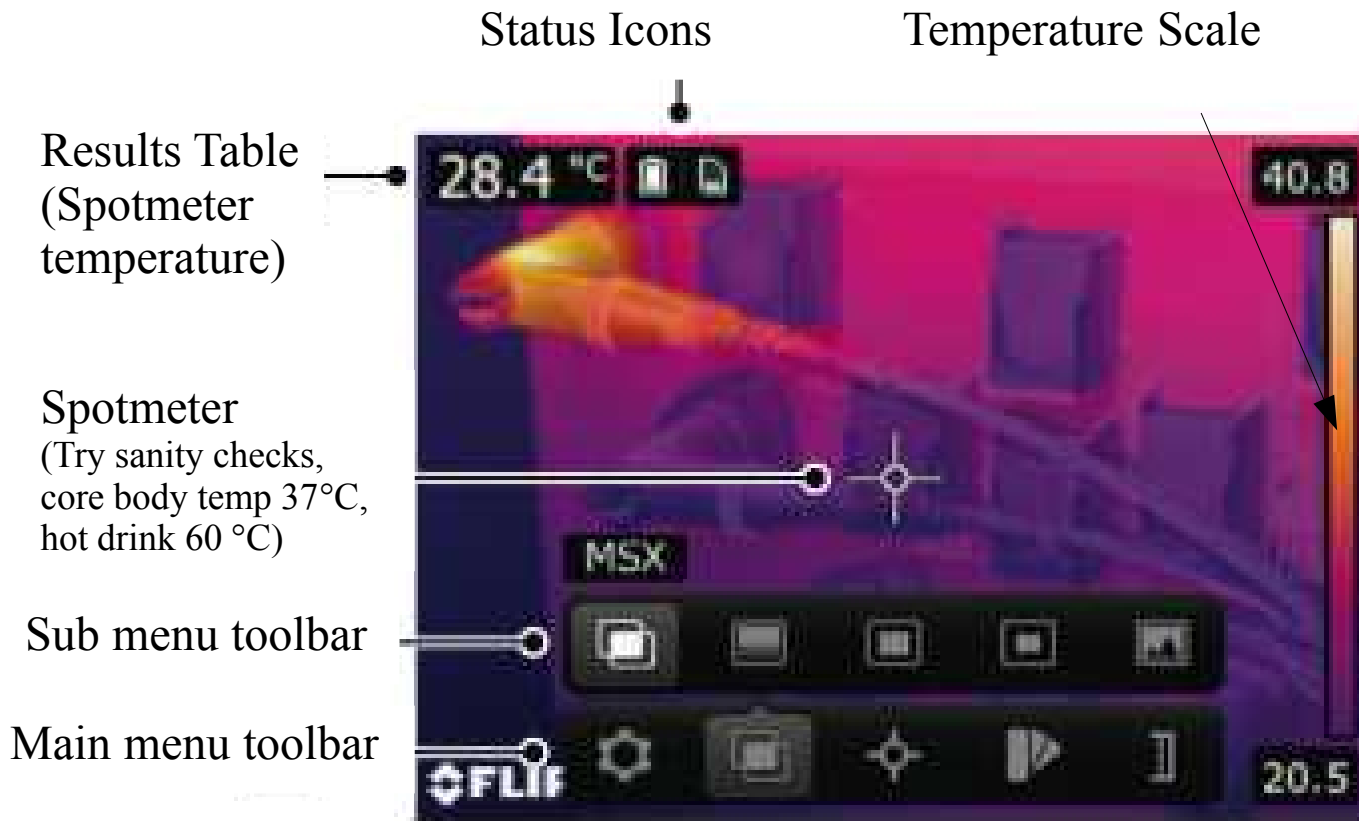
What can we learn from this image?

- It is Winter. Ground temperature just above 0°C
- From the image, we know it is a house - recognition.
- The heating is on, or was on (thermal inertia)
- Roof is probably insulated
- Photo was taken with sufficient light for digital camera to produce image (MSX)
- Range lock is in use (white out effect)

# The Flir E6 Camera



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Source: FLIR

Lock mode is good when:

- Comparing similar objects (e.g. outside walls of your house). Lock on the image with the widest temperature range and the image colours will have the same meaning.
- Taking an image which has small temperature gradients when there is a very hot or very cold point in the range. Point the camera away from the hot / cold area, lock the range and then take the image.

## The camera can operate in:

Auto mode – continuously looking for the best image, brightness and contrast

Lock mode – temperature span and the temperature level are locked

## Example of using navigation pad to change settings:

- 1) Push the centre of navigation pad and select Temperature Scale from the toolbar.
- 2) Select either Auto or Lock



# Saved Images



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## DOWNLOAD YOUR IMAGES

Download the images onto your computer.

Install FLIR tools to see all the temperature data.

If you edit the JPG outside FLIR tools all the temperature information will be lost.

## DELETE ALL YOUR IMAGES FROM THE CAMERA

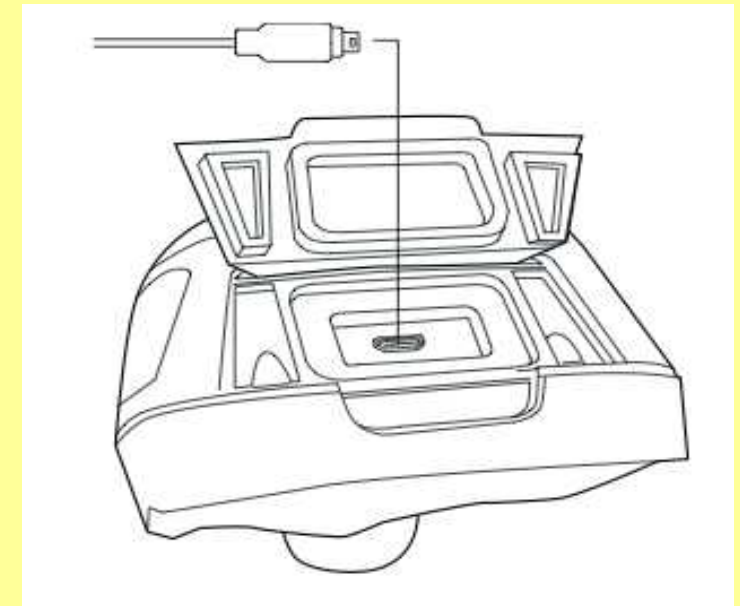
- Push the centre of the navigation pad.
- On the toolbar that appears select settings.
- In the dialog box select Device Settings
- In the dialog box select Reset options
- In the dialog box select Delete all saved images.

## CHARGE THE CAMERA

It can take up to 2 hours to charge if the battery is flat

The USB mini-B connector is used for:

- Charging the battery using the FLIR power supply
- Moving images from the camera to a computer for further analysis in FLIR Tools.



Software for the MAC: In the app store, search on FLIR and download the FLIR Tools app.

For Windows PCs: Download from <http://www.flir.com/thermography/americas/us/view/?id=54865>

# Surface properties / Emissions



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The **emissivity** of a material ( $\epsilon$ ) is the relative ability of its surface to emit energy by radiation compared with a black body at the same temperature (a black body has  $\epsilon = 1$ ).

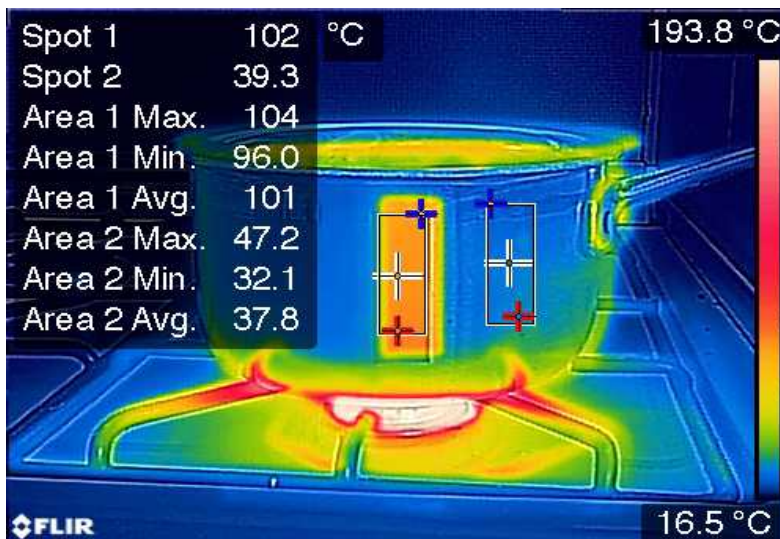
Thermal and electrical insulators have high emissivities and measurement is ok

wood, plastic, soil, concrete, rubber  
PVC, painted surfaces, building materials

Metals are poor emitters ( $\epsilon$  of at best 0.25) and measurement is tricky.

copper, steel, iron, brass, nickel,  
chromium, zinc, lead, aluminium

## Water Boiling At 100°C in Stainless Steel Pan ( $\epsilon = 0.16$ , not 0.95 as set)



Most building materials have high emissivities (concrete 0.95, brick 0.8). Small temperature differences where building material changes may be an emissivity effect rather than heat loss differences.

Black insulation tape (high emissivity) will always show the true temperature. Area 1 is black insulation on the stainless steel pan.

# Reflections



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Something always reflects. Here it is a person.

Reflection is more of an issue when emissivity is low.

If a hot or cold spot moves when you change camera position its likely to be a reflection.

In this picture the hot spots on the roof are sun patches, if its not been dark for a while don't confuse these with heat loss.



# Building Diagnostics



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## **Ideal Conditions for Use**

- Building interior  $>10^{\circ}\text{C}$  ( $15^{\circ}\text{C}$  ideal) warmer than outside, turn up heating in advance, if necessary.
- No recent direct sun, rain or strong winds ( $>10$  km/h)
- Two hours after sunset solar effects are minimal

## **GOOD PRACTICE**

- Be methodical - don't miss things
- Capture the whole scene and close-ups.
  - When outside, point at the house, excluding any sky, put the camera into lock mode to get the optimum colour range.
  - Take wide angled views to see conduction losses through walls, doors, windows and roofs.
  - Look for areas of unexpected high heat loss (hot areas when outside or cold areas inside) and focus in to investigate)
- Make comparisons.
- Look for moisture, draughts and heat loss.
- Keep notes: subject, location, suspected problem,

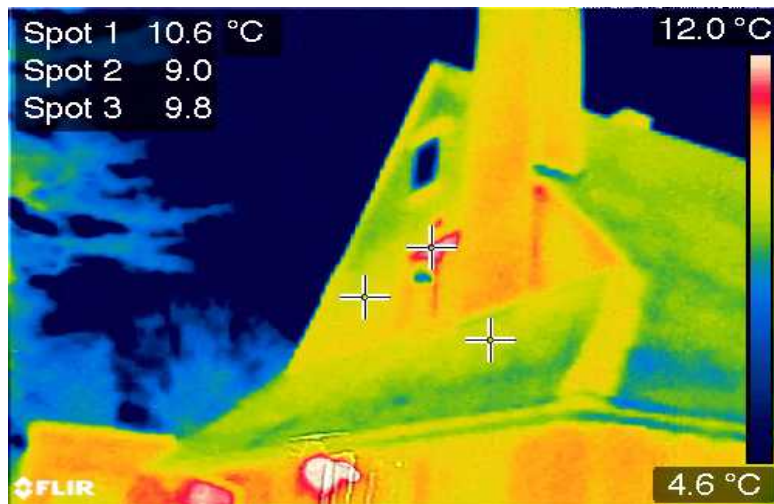
Remember:

Inside temperature affects outside temperature. Don't assume that houses / rooms are heated to the same temperature.

# Insulation



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## Detect thermal bridges and decide whether they can be eliminated

Cross joining bricks in an early cavity wall – external or internal insulation would reduce the problem.

Pipework – is it all necessary? Can the cross-section be reduced?

**Thermal bridges show as cold spots on the inside and warm spot on the outside. They occur when a highly conductive or non-insulating material passes through an insulating layer which separates the interior and exterior of a building.**

## Detect missing or defective Insulation

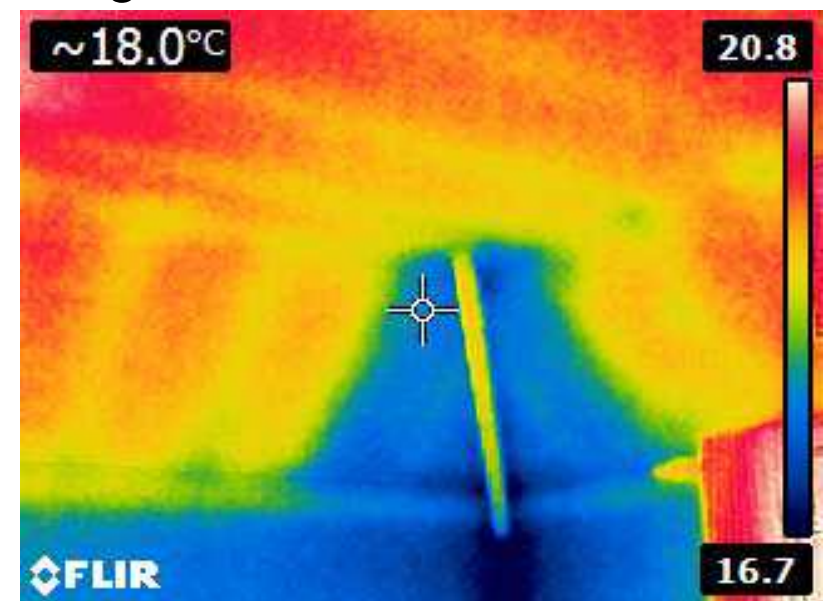
Does injected cavity wall insulation reach the corners, floor and roof?

Is interior insulation sealed properly?

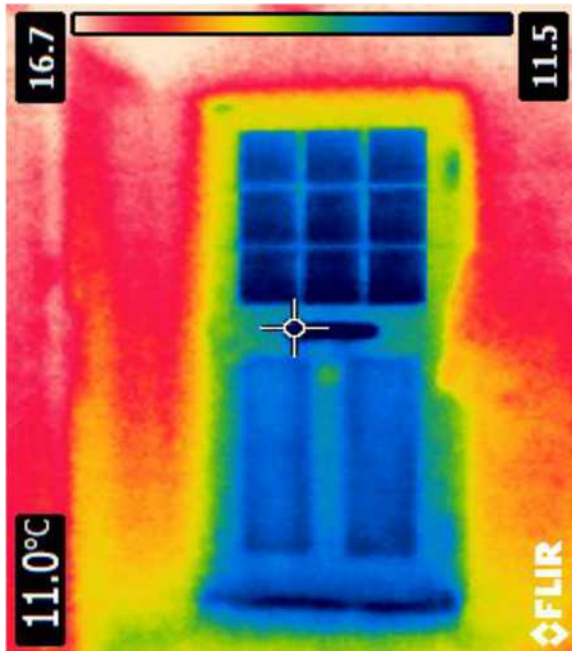
Has suspended floor insulation dropped?

Is the loft hatch insulated?

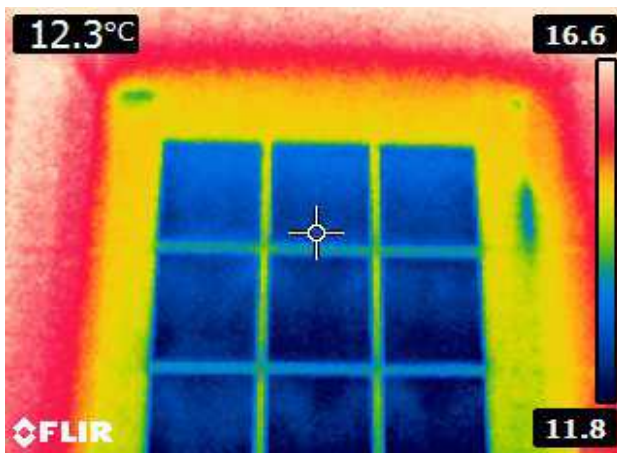
Does insulation extend down when the roof goes down into the first floor?



# Windows and Doors



Draughts show as irregular cold area near the crack or gap.



## Detect defective windows and doors

Are curtains channeling hot air out of the house?

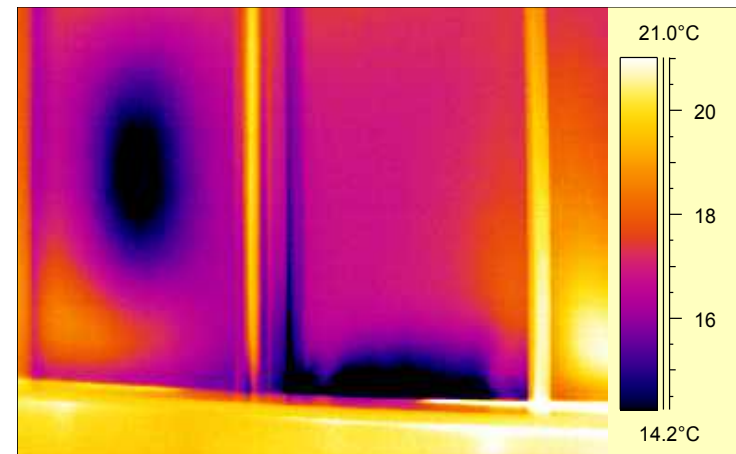
Do door and window openings seal tightly when closed?

Is the join between the window frame and house completely sealed?

Are trickle vents air tight when shut?

Whats coming through your letterbox and keyhole?

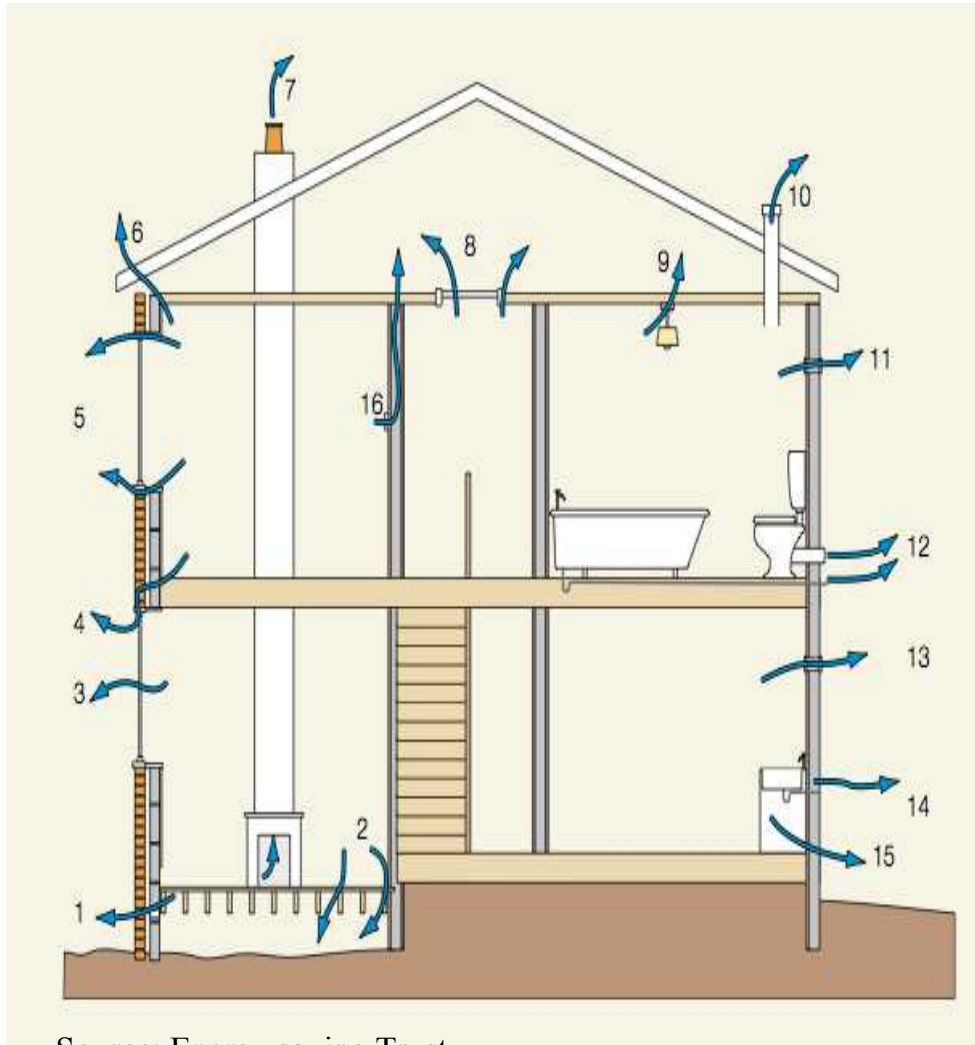
Has the gas leaked from a double glazed window?



Source: FLIR

# Draughts / Air Infiltration

## Detect draughts and seal where ventilation is unnecessary



Source: Energy saving Trust

1. Underfloor ventilator grilles
2. Gaps in and around suspended timber floors (skirting and floor boards)
3. Leaky windows and doors
4. Pathways through floor / ceiling voids into cavity walls and then to the outside
5. Gaps around windows
6. Gaps at the ceiling to wall joint at the eaves
7. Open chimneys
8. Gaps around loft hatches.
9. Service penetrations through the ceiling / roof.
10. Vents penetrating the ceiling / roof
11. Bathroom wall vent or extract fan
12. Gaps around the bathroom waste pipes
13. Kitchen wall vent or extractor fan
14. Gaps around kitchen waste pipes
15. Gaps around floor to wall joints (particularly timber frame)
16. Gaps in and around electrical fittings in hollow walls.

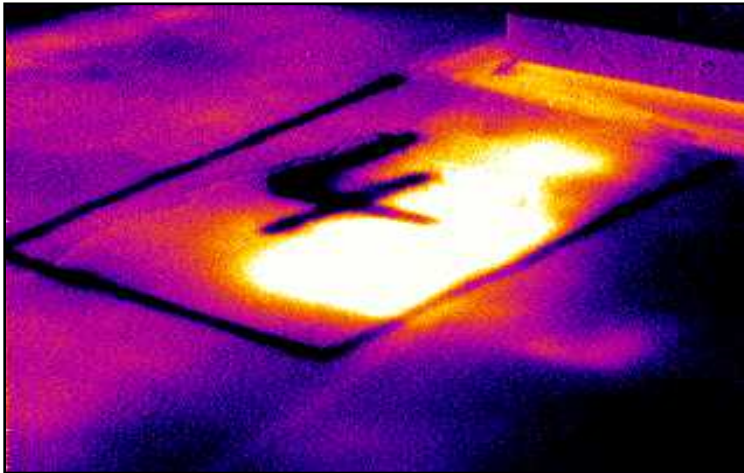
Remember some air vents are required, e.g for fires, boilers and floor ventilation!





## Detect moisture in / on walls and roofs

- Are there blocked drains or leaky pipework?
- Is a flat roof beginning to fail?
- Are there missing tiles?
- Does brickwork need repointing or external render repairing?



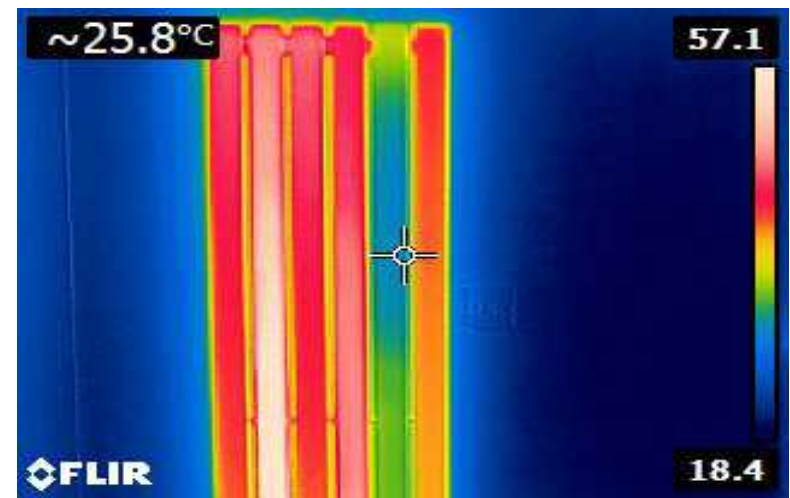
Source: FLIR

## Detect condensation at cold points before mould appears

- Can you increase the amount of ventilation?
- Could moving furniture increase air movement?

## Heating

- Detect if underfloor heating warmth lines are flowing where you would expect.
- See how draughty an open fire is when not in use



## Check radiators

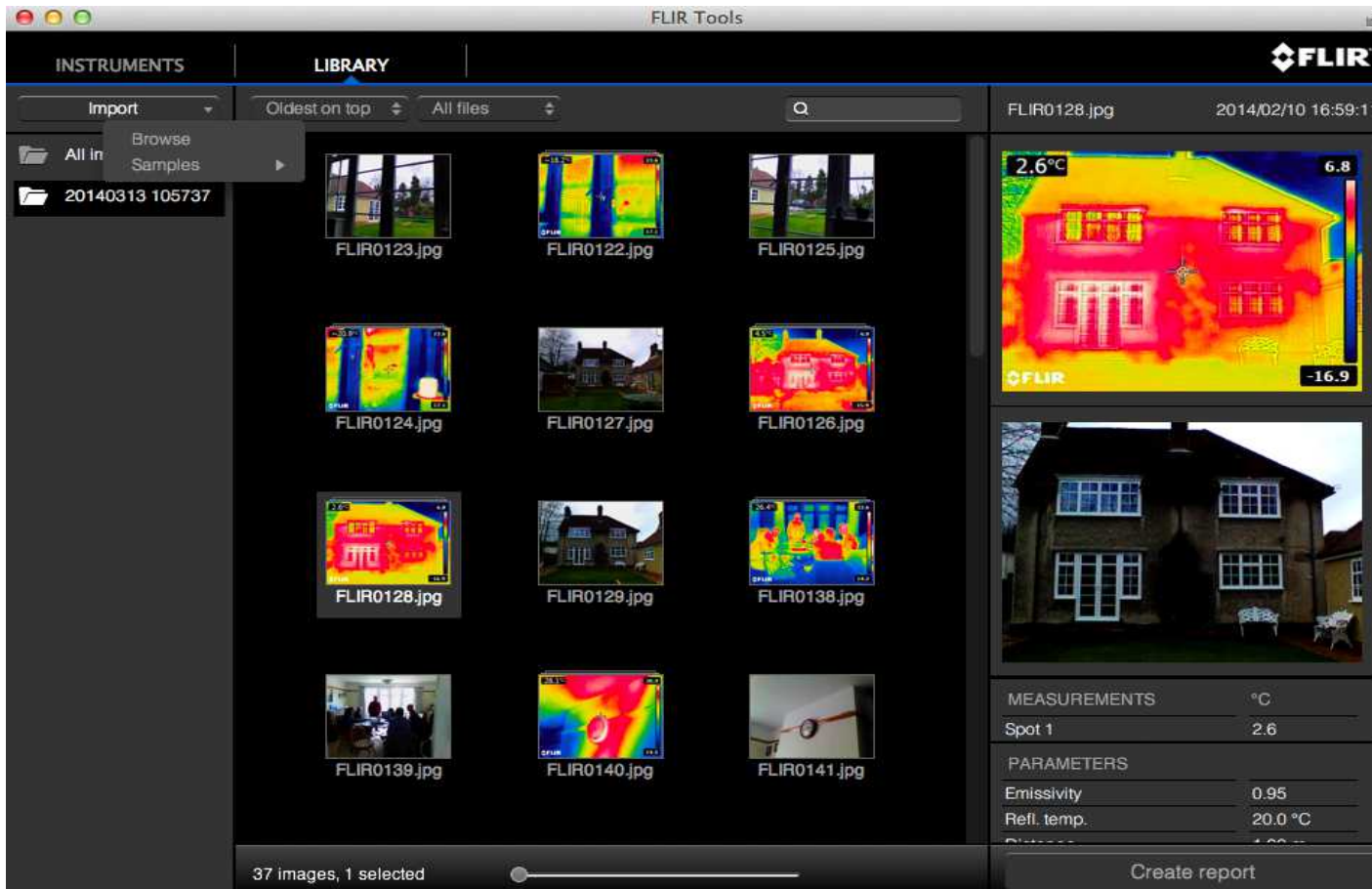
- Cold at the bottom suggests sludge and the central heating system would benefit from draining and cleaning.
- Cold at the top and air has got in, and the radiators would benefit from bleeding.



# The Software

The FLIR E6 jpg images can be viewed as pictures and some information gained.

Downloading the FLIR analysis tools and importing pictures into the software allows you to explore the information (temperatures) in the image and improve how the information is displayed.



FLIR Tools

INSTRUMENTS LIBRARY

Import Oldest on top All files

All in Browse Samples

20140313 105737

FLIR0123.jpg FLIR0122.jpg FLIR0125.jpg

FLIR0124.jpg FLIR0127.jpg FLIR0126.jpg

FLIR0128.jpg FLIR0129.jpg FLIR0138.jpg

FLIR0139.jpg FLIR0140.jpg FLIR0141.jpg

37 images, 1 selected

FLIR0128.jpg 2014/02/10 16:59:11

2.6°C 6.8

-16.9

MEASUREMENTS °C

Spot 1 2.6

PARAMETERS

Emissivity 0.95

Refl. temp. 20.0 °C

Create report

For example:

Add spots, area boxes, circles, lines, Delta T, annotations.

Thermal tune level and span, change the palette, or adjust parameters such as emissivity, reflective temperature.

The information saved on the camera is not restricted by how you viewed them, including range lock.


# Borrowing the Camera



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## Volunteers agreement, Booking the Camera, Donations

**Using TTL's Thermal Imaging Camera:  
Borrower Agreement**



The Flir E6 Thermal Imaging Camera is an expensive piece of equipment and should be used with care according to the procedures agreed by Transition Town Letchworth which are set out below.

1. The camera is not insured if it is left unattended in an area accessible to the general public, left in unlocked rooms or vehicles or lent to a person who is not a Member or Temporary Member of Transition Town Letchworth. Anyone borrowing the camera is agreeing to keep the camera securely in their custody.
2. Transition Town Letchworth provides training on the use of the imager, its software and will explain how the imager can help to detect different home energy efficiency issues. Only people receiving this training should use the imager. It should not be lent, without supervision from a trained person, to any untrained people.
3. Transition Town Letchworth are not responsible for any decisions that a householder makes on home improvements which were based on information in a thermal image.
4. The imager must be returned to the agreed place at the agreed time in the same condition as it was received. It is insured for accidental damage.
5. Transition Town Letchworth are providing equipment that would normally only be available to householders at a significant cost. As a community group we do not charge for this equipment. However, there are administration and insurance costs. If you would like to make a small donation to Transition Town Letchworth (perhaps in the order of £5 to £10) from each house surveyed this would be appreciated. Donation envelopes can be found in the camera case.
6. Please copy any data you need from the camera before you return the camera. The householder is the owner of any data and decides how it will be stored and processed. If someone else is going to process the images, it is important that the householder knows who will be sending them information and when. All data remaining on the camera on its return to Transition Town Letchworth will be deleted.

By signing below, I confirm that I have read, understood and agreed to this 'Borrower Agreement' on the use of the Thermal Image Camera, that I have received training in its use and will only use it in connection with Transition Town Letchworth projects. I declare that I will not use the Thermal Image Camera for any commercial or fee-paying purposes, nor lend nor re-hire it to any other person. If I am not a full member of Transition Town Letchworth, I also understand that during the time that I have the camera I am agreeing to a Temporary Membership of Transition Town Letchworth for the duration of my safekeeping of the Thermal Image Camera until it is returned to Transition Town Letchworth.

Name \_\_\_\_\_  
Address \_\_\_\_\_  
\_\_\_\_\_  
Email \_\_\_\_\_ Phone \_\_\_\_\_  
Signature \_\_\_\_\_ Date \_\_\_\_\_

Date Borrowed      Date Returned      TTL administrator signature confirming return of camera

Lets Get Surveying!