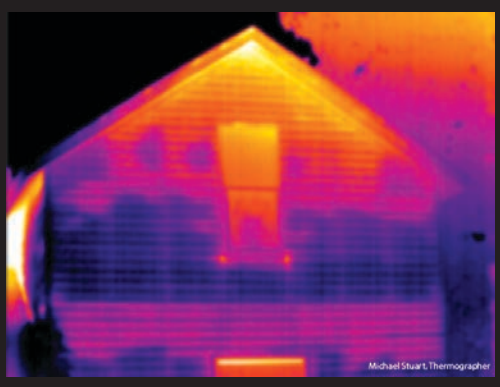
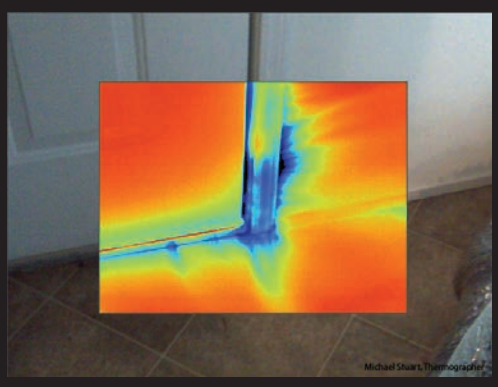
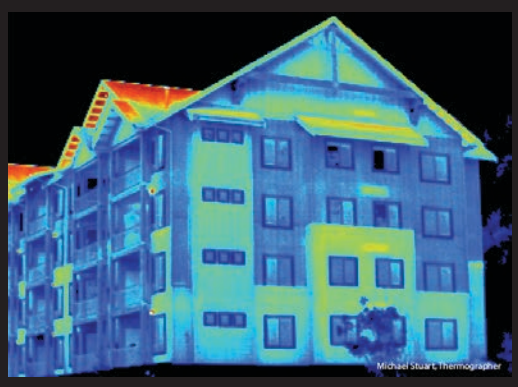
FLUKE®

Thermal imaging basics
For building inspections

An infrared building inspection guidebook







Contents

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Introduction

Thermal Imaging technology has changed dramatically over recent years. Thermal imagers (or infrared cameras) are now more affordable, portable and accessible than ever before. With this dramatic shift, thermal imagers have emerged as a key technology for building inspection work worldwide.

Thermal imagers allow many building professionals to work faster, spend less time in the field, spot and document hidden issues, and provide new services for clients.

In this booklet, you will learn more about building inspection using thermal imaging, including:

- **Basic principles of how a thermal imaging camera works**
- **Common thermal imaging building applications**
- **The benefits of thermal imaging**
- **Best practices for performing an infrared building inspection**
- **Tips on how to choose the right thermal imager for your application**

What is thermal imaging?

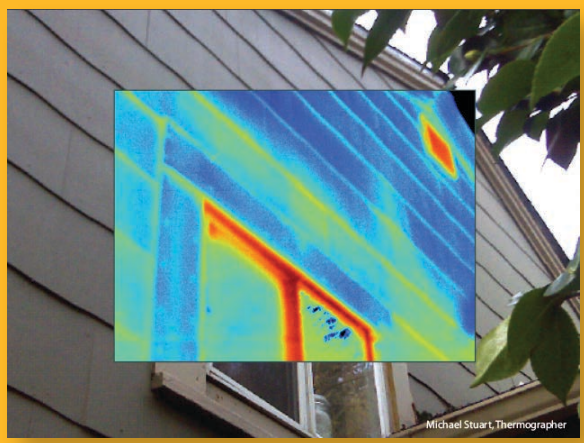
Thermal imaging creates images using energy from the infrared portion of the electromagnetic spectrum, very similar to how a digital camera creates images using the energy in the visible spectrum.

All objects above absolute zero emit infrared energy, and the amount varies depending on temperature and other factors. An infrared camera detects and measures the infrared energy emitted by an object and its surroundings, and then can calculate the apparent differences in temperature.

Because infrared cameras display apparent surface temperature variations, they can often allow you to detect issues that are not visible to the naked eye, and monitor, diagnose and document them without other more expensive, destructive testing.

Thermal imaging can be used to help identify many problems, including:

- Unexpected air leaks in and out of the building
- Poor, missing, or settled insulation
- Moisture in roofs, walls, and floors
- HVAC system issues
- Issues with radiant-floor heating systems
- Electrical faults
- Plumbing leaks
- Condensation issues
- Construction defects and thermal bridging
- Window and door installation and performance issues
- And much more...



The benefits of thermal imaging

Because thermal imaging allows for non–invasive inspections, it is a valuable tool for energy audits, weatherization, restoration and remediation, and general building inspections. It allows the detection and documentation of problems, without costly damage to the building or home.

With thermal imaging, you can:

Increase your business

Many customers now request infrared inspections and will pay a higher price compared to a traditional inspection. Fluke thermal imaging allows you to offer more services to your customers so you can charge more fees and generate more business.

Differentiate from your competition

By offering thermal imaging as a service and showing before and after images in your customer reports and marketing materials, you can stand out as more advanced and credible than your competition.

Save time

Thermal imaging is fast and easy. Inspection and diagnosis that previously required invasive testing can now often be done more quickly with a thermal imager. Working faster allows you to do more inspections in a day—overall spending less time in the field and more time growing your business.

Reduce liability

Telling someone they have a problem is not nearly as convincing as showing them a thermal imaging report. Infrared cameras can document issues, direct work priority, and then verify that repair or remediation work was done properly.

Building inspectors, energy auditors, HVAC technicians, restoration and remediation contractors, facility managers and property owners use thermal imaging to find hidden problems faster with infrared and visual proof.

Thermal imaging **applications**

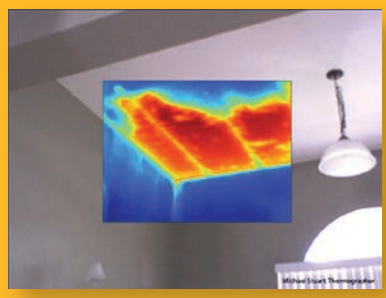
Thermal imaging allows you to quickly identify many building defects and issues. Some of the most common uses include:

Air leaks

Cold air seeping through a leak will cool the areas around it. This cooling is visible with a thermal imager. Thermal imaging can also be used to identify heat escaping from a structure. When combined with a blower door, an infrared camera is a powerful tool to identify potential convective energy loss. Your customers can achieve significant energy costs savings once these issues have been resolved.

Poor or missing insulation

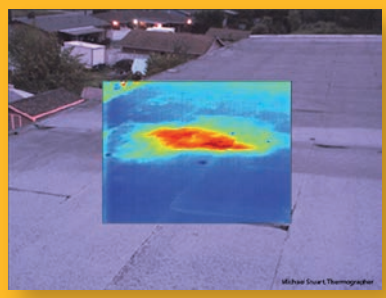
When insulation is missing, damaged, or has settled over time, a different thermal pattern is often visible compared to the rest of the wall. These areas can often be a source of conductive heat loss or gain, and, if bad enough, lead to significantly higher energy usage. Under the proper conditions, they are easily detected and documented with an infrared camera.



Moisture in roofing

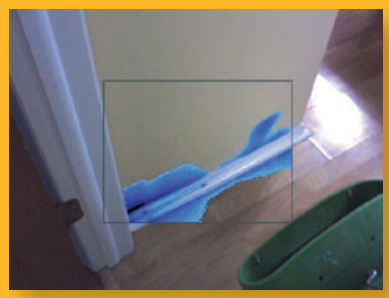
Moisture in roofing materials often leads to two scenarios—water leaks into the structure, and reduced insulating properties of the roof itself. Due to the difference in thermal capacitance of wet building materials versus dry ones, moisture problems in flat or low-slope built-up roofs can often quite easily be detected with the use of a thermal imager.

Infrared inspections can often extend the life of a roof by accurately identifying the critical problem areas and preventing premature full replacement costs.



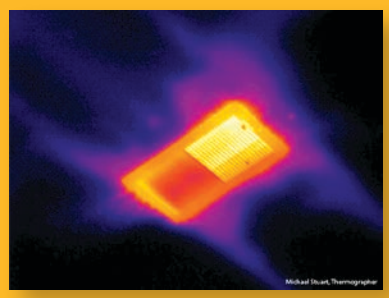
Moisture in walls and floors

Similar to roof leaks, thermal imagers can be used to find moisture trapped in walls and floors. Damp areas change temperature more slowly than dry areas, and are subject to evaporative cooling, which allow them to become visible to the thermal camera. Causes of this unwanted moisture include plumbing leaks, leaks from the outside, and condensation. Moisture in these types of situations can often be a precursor to mold, mildew, and air quality problems. This, in turn, can create both occupant comfort and health issues with prolonged exposure.



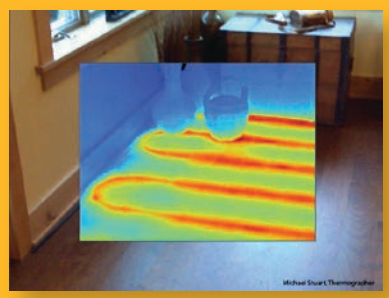
HVAC system issues

A thermal imager can be used to determine whether HVAC equipment is heating or cooling properly, electrical components are working as designed, and determine if ductwork is properly delivering the conditioned air to the right places, or is instead leaking unexpectedly increasing the costs to heat or cool the building.



Radiant floor heating system issues

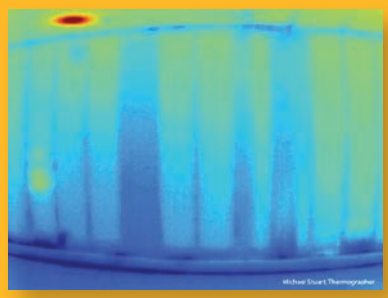
Both electrical and hydronic in-floor heating systems are subject to installation issues and failures over time. Thermal imaging can be used to locate floor heating, identify leaks and obstructions or short-circuits (depending on the type of system), troubleshoot un-even heating issues, and verify installations and repairs.



Electrical issues

Heat can often be a sign of electrical issues such as loose, over-tightened, or corroded connections, or other component failures. These areas can readily be seen in a thermal image, allowing qualified individuals to correct problems before significant damage or a major failure occurs.

Thermal bridging



Thermal bridges are pathways by which heat can move from one place to another via conduction or direct contact between building materials. It is normal to see this in many types of construction, but minimizing it with proper design and insulation can reduce conductive heat loss or gain in a building envelope. Under the proper conditions, a thermal imager allows the user to easily detect and document areas where thermal bridging is occurring, and decide whether any action is warranted.

Renovations/retrofit

When preparing for a renovation, a thermal image can often help to indicate the underlying structure and design, and speed up both planning and construction. Before and after infrared images also can verify that a retrofit was done correctly and will be more effective at reducing energy costs.

Best practices for performing a residential infrared inspection

There are many steps in performing an effective residential infrared inspection. Best practices for the preparation and conducting of an infrared inspection include:

1. Perform a visible inspection of interior and exterior. Note any unusual visible issues or areas of concern.
2. Confirm a difference in temperature (delta-T) of at least 10 °C (18 °F) from interior to exterior surfaces (or confirm that conduction inspection can effectively be performed with less). Typically, a stable difference in temperature for a period of at least four hours is preferred.
3. Record interior air temperature and humidity.
4. Record exterior air temperature and humidity.
5. Record exterior wind direction and speed.
6. Record any other environmental factors such as precipitation, position of sun, etc. These factors may limit the ability to conduct an effective infrared inspection in some areas.
7. Close all exterior doors, windows, etc on the building envelope.
8. Open all interior doors.
9. Make sure that HVAC system has been turned off for at least 15 minutes.
10. Perform a systematic inspection of interior of residence to inspect for conduction issues (insulation, thermal bridging, etc). Note any anomalies or unexpected thermal patterns.
11. If conditions permit, perform a systematic inspection of exterior of residence to inspect for conduction issues (insulation, thermal bridging, etc), if possible with weather conditions. Note any anomalies or unexpected thermal patterns.
12. Make sure that all combustion appliances (furnaces, stoves, heaters, etc) are completely turned off. If a fireplace is present, cover all ash with damp paper or otherwise contain it so it does not spread.
13. Properly install a blower door.
14. Depressurize residence to approximately 20 pascals.
15. Perform a systematic inspection of residence interior for air infiltration (assuming approximately 5 °C (9 °F) delta-T or appropriate confirmation that inspection can still be reasonably conducted). Note any anomalies, interstitial air bypasses, or areas of air infiltration.
16. Reverse direction of blower door and/or pressurize house to approximately 20 pascals.
17. Perform a systematic inspection of residence exterior for air exfiltration (assuming approximately 5 °C (9 °F) delta-T or appropriate confirmation that inspection can still be reasonably conducted). Note any anomalies, air bypasses, or areas of air exfiltration.

Choosing the right thermal imager

Four areas you may want to consider when choosing a thermal imager are:

1 Infrared Performance

Many standards and guidelines exist worldwide that provide recommendations on the proper use and methodology when using thermal imagers for building inspections. The minimum equipment requirements proposed by RESNET (Residential Energy Services Network) are noted in the box to the right:


Caution

Many cameras in the market do not meet this minimum criteria, and are not appropriate for building diagnostics use.

IR resolution:
Minimum – 120x120

Thermal sensitivity:
100mK or better
(lower is better)

Field of View (FOV):
Approximately 20 degrees or more is recommended

2 Building Inspection Environment

When shopping for a thermal imager, it is easy to overlook key ergonomic and environmental features that impact basic use. It is important to consider:

Ergonomics

Having a thermal imager that allows you to operate the imager and focus one-handed is highly recommended.

It is very likely that you will at some point need to use your thermal imager in an attic, crawl space, or another unstable place where having a free hand for stability will better allow you to get the job done.

One-handed usage allows a free hand for ladders or crawl spaces

Durability

In order to protect your investment, find a thermal imager designed to handle tough working conditions. Fluke designs its imagers to handle a 6.5 foot (2 meter) drop and are protected from water and dust ingress.

Minimum requirements:

Drop rated – 6.5 feet

No dangling parts (i.e. lens cap,wrist strap) that can get caught up

IP 54 dust and ingress protection

Protective lens guard and integrated cap

Working in all extremes of weather

Make sure that your imager has an operating and storage temperature that is suitable for the environment where you are working.

3 Key Fluke Features

Fluke thermal imagers have had significant changes over the past few years—changes that we consider essential to help you do your job easier and faster.

- Get an in-focus image like never before with a touch of a button. LaserSharp® Auto Focus, exclusive to Fluke, uses a built-in laser distance meter that calculates the distance to your designated target with pinpoint accuracy. The laser distance meter can calculate distances up to 100 feet and displays the distance on the image.
- IR-Fusion® technology, with AutoBlend™ mode, combines an infrared and thermal image for aid in detection and analysis as well as professional, understandable reports
- Built-in Voice Annotation (Recording) allows you to record notes and findings easily (Clumsy headsets and microphones are no longer needed.)


Full infrared


Full AutoBlend™ infrared


Full color alarm infrared


Picture-in-picture infrared


Picture-in-picture AutoBlend™ infrared


Picture-in-picture color alarm infrared

4 Software

Best to consider:

Professional reporting and analysis software included with free upgrades and unlimited licenses

Fluke thermal imagers come with professional software that you can use to view, annotate, and analyze your thermal images. This software allows you to create fully-customizable and professional reports.

Some thermal imaging companies only offer you a very basic software package with the purchase of your imager. They charge extra for more robust software that has the needed features for comprehensive analysis and reports, with licensing limitations allowing installation on only one computer.

Software is such a critical part of the thermal imager purchase, it is important to find a professional software package that meets your needs. It is best to look for a thermal imaging system that includes a very robust and flexible professional software with unlimited use and free updates for the life of the product. That way, you can be sure that your investment continues to pay off.

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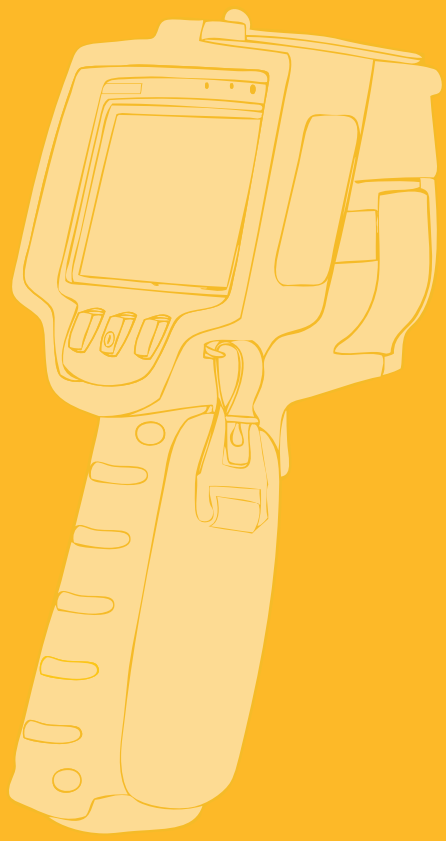
Checklist for choosing a thermal imager for building inspections

- ☐ Minimum infrared performance
- ☐ One-handed usage
- ☐ Drop test rated for 6.5 feet
- ☐ Integrated hand strap and lens protection
- ☐ Key features to consider
  - ☐ LaserSharp® Auto Focus System
  - ☐ IR-Fusion® technology
  - ☐ Built-in voice annotation
- ☐ Included easy-to-use, professional reporting and analysis software that doesn't limit installation to a single PC and includes free upgrades for the life of the product



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