BY DOUG HORGAN

New Infrared Options for Remodelers

Four years ago our company invested in a $2,000 Flir i7 infrared (IR) camera. This was a steep investment, but we put the camera to good use on many of our jobs and it was well worth it. Recently Flir introduced a couple of lower-priced IR cameras—the TG-165 (about $400) and the C2 (about $700)—which we were looking forward to evaluating. Before I talk about them, though, I want to explain how we use thermal imaging on our jobs, to provide context for the IR-camera features we like.

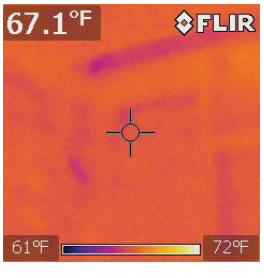
USES FOR THERMAL IMAGING

We use our IR camera mostly to find and fix air leaks and insulation flaws. It's particularly helpful as a quality check for spray-foam work **(1, 2)**. Our experience is that even the best crews accidentally leave voids. The thermal camera shows these quickly and clearly, and when the crews can see the issue with their own eyes, they don't feel we're being overly strict when we ask them to fix the gaps.

When you're looking for air leaks and insulation, it helps to use the camera with a blower door. By depressurizing the house and pulling outdoor air in through air leaks, even small leaks will become evident (see "Thermal Imaging With a Blower Door," Nov/13).

Better communication. Communicating problems to installers is a huge plus. What I hadn't anticipated is how useful an IR camera is for helping clients understand the value of air sealing—particularly in attics, along band joists, through cantilevers, bays, and so on—and insulation. When we first meet, our clients really have no idea. But when we hand them the camera, or email them images showing freezing air blowing into their living spaces, their heads instantly start nodding. The key is being able to provide clear visual evidence, so good screen resolution and output options are essential camera features for us.

Leaks and moisture. A thermal camera is also good for leak investigations. Most porous materials are cooler when wet (because the water evaporating from the surface cools it), and the camera can "see" what areas have been affected by a leak from all



1. Visually, the foam in this wall looks pretty good. **2.** On the camera, a flaw in the narrow corner stud bay is clearly visible as a cold (dark) spot.

Photos: Doug Horgan

WORKING WITH INFRARED

An IR camera is only indirectly reading what you are looking for—it measures infrared light emissions, not temperature. Under certain conditions, you can get anomalous readings. Here are things to watch out for.

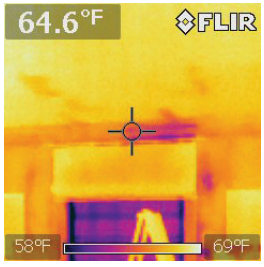
Emissivity. Most of the surfaces we see emit about the same amount of infrared, so temperature readings are comparable. The exceptions are low-emitting surfaces like shiny metal or reflective, smooth surfaces like glass. These surfaces reflect temperatures around them and don't emit much IR when hot. To see how these surfaces compare, I put a strip of blue tape on the surface. The tape has a similar emissivity to other building components and will "read" correctly.

Ranging. Most of the cameras I've used automatically set one end of the color scale to the coldest temperature in the frame, and the other end to the hottest. The scale is relative to what's in view, so when you swing around a room looking for cold spots, the color that represents "cold" can change. This is especially noticeable when a hot light bulb comes into the picture. Suddenly the high temp in the picture goes from 75°F to about 200°F, and areas that looked warm suddenly shift into the "cold" range.

The way to prevent this is to lock the range. Point the camera at a representative area of the room, with no major heat sources or freezing cold window frames, and use the lock feature to hold the color range steady

the way across a room, as shown in these photos of a ceiling below a bath leak **(3, 4)**. The wet areas appear as "cold" spots. It's not that you couldn't figure it out with a moisture meter or by cutting open the finishes, but with the thermal camera you can quickly evaluate the entire affected area of drywall or flooring. You can take photos, which help clients and insurance companies understand the scope of work, and you can start at the source of the problem rather than having to trace it from the area first found to be wet.

In-floor heating. We use an IR camera on heated floors, too. Besides using it for ordinary problem solving (for example, to determine which loop is which on an 8-loop header), we often use it when we need to return to a job. In our custom construction business, we need to drill a hole or install a floor-mounted door bumper in the middle of a heated floor a couple of times a year. With the thermal camera, we can see exactly where tubing or electric heat wires are located. Even when they are 1 ½ inches apart **(5)**, we can confidently locate where to put the door stop or the mounting point for a frosted glass panel. One trick we've learned is to put masking tape on the floor in the area in question and mark that with pencil. If you warm up the pencil in your hand for 10 seconds, it will show up nice and bright on the camera screen and you can verify you are marking right on top of the warm wire in the floor.



3. We knew some of this ceiling was wet from a bath leak above. But where exactly were the wet areas? **4.** With the infrared camera, we could see the wet areas as cold spots (darker colors), showing the extent of the leak.

5. The Flir i7 autoranging has proven effective in use. The range can be manually locked. **6.** The TG165 lacks a lock feature and the automatic ranging sometimes doesn't show enough contrast.

WHICH MODEL?

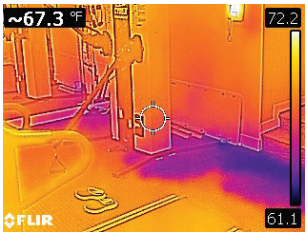
This is not a comprehensive review of all the models available. But a comparison of the three Flir models we've used can provide a basis for making a buying decision.

The TG-165 is a solid performer at the tasks it's designed for. It's a compact, solid tool that feels like it would hold up fine in a tool bag. It's designed primarily for electricians, HVAC techs, and facility managers as an alternative to a pistol-grip spot thermometer. At $400, it's roughly twice the cost of a top-of-the-line Fluke or Klein spot thermometer. But in addition to measuring temperature, this tool can provide an infrared image of the whole area around the spot you're aiming at—useful information that will help in verifying electrical installations and diagnosing mechanical problems. For a general contractor, though, it lacks key features that make an IR camera such a worthwhile investment.

In particular, the smallish screen has a low resolution (60x80) that does not show much detail. You *can* find hot and cold spots in walls, ceilings, and floors, as long as you move around and approach the spot to get an accurate gauge of temperature differences—but the saved images are hard to read and not very useful in reports or emails.

I also found the autoranging feature especially frustrating. The TG165 seems to rerange frequently, and the colors constantly cycle back and forth. When I used the tool to search for warm floor heat wires, for example, I couldn't confidently see the wires . The tool showed the whole floor at the same color **(6)**. My old i7 was able to range correctly to show the heat wires in a different color from the rest of the floor.

The C2 (7) is almost as useful as our i7, but at much less than half the cost. This new, compact model combines a visual camera



7. The author at work with the Flir C2 , which is only about as big as a smartphone. **8.** With the addition of "MSX," this image from the C2 of wet carpeting in a workout room is more useful and is suitable for reports and emails.

with an IR imager. You can set it up to save both infrared and visual images at the same time, which makes reporting and later viewing much simpler. (To get a visual image with our i7, I must first take the time to set the same times on a separate pocket camera and on the i7, then walk around taking pictures with both devices. Later I have to match up the images from the two sets and put them together for a report.)

A key feature is what Flir calls an "MSX" overlay. This view combines the IR image with faint lines outlining all the objects and patterns from the visual image. The combined image provides a clear and recognizable representation of the area, while also providing thermal information **(8)**.

Though the C2 uses the same 80x60 resolution infrared sensor that's in the TG165, the addition of the MSX overlay makes the image more readable—even more readable than the 120x160 infrared-only images we get from the i7.

The C2's touchscreen makes access to options quick and simple—better than the mushy buttons on our i7, which are hard to operate. (I often hit the adjacent one in addition to the one I want). On the C2, thermal range can be locked with a single touch, and other options are usually two touches. My fat, clumsy fingers had no trouble with the on-screen buttons.

The physical button on the top of the tool for taking photographs was a bit stiff on the demo unit. I felt it was hard to hold the camera steady while pressing it. But the pictures all seemed to come out fine.

One interesting shortcoming is shooting in dim light. Because the key to usable images is the MSX overlay, the visual camera needs to be able to "see" the outlines of objects in the photo area. When I tried using the camera to take pictures outdoors on a cold morning, the dim pre-dawn light was inadequate for the visual camera, and I got no outlines on my infrared image. With the low-resolution infrared sensor in the C2, the picture was not very useful—though the tool was still great for actively looking for hot and cold spots. A similar situation happened in a poorly-lit crawlspace. The camera was still useful—I could see one of the crawlspace walls was much cooler than other areas—but I couldn't get the great picture I could get when there was better light.

I think the next step up from the C2 is a $2,700 E6 camera, which has MSX as well as a much larger sensor.

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within that narrow range. Hot objects won't change the color range as you scan the room and you'll be able to see minor temperature differences.

Evaporation is a cooling process, so wet areas appear cooler. With most building materials, the line between wet and dry is clearly visible from across the room, and the camera is a fantastic tool for identifying these locations. With some materials, though, evaporation is minimal, and little or no difference shows on screen. Polyurethane floor finish and glazed tile, for example, don't let water through. Use a moisture meter for these materials. I always carry one when investigating a leak.

Thermal capacitance. When you look at a wall, the studs can be either warmer or cooler than the surrounding drywall—depending on a number of factors. Remember that things cool off at night (and then take a while to warm up), and warm up during the day (but take a while to cool off). Sometimes the studs look cooler than the wall even during the air-conditioning season, particularly in the morning, due to night cooling.

Radiation effects. If you ever bring a camera out on a sunny day, you'll quickly realize the warm sun overwhelms any effects of insulation or water. First thing in the morning is the only good time to see a lot of exterior issues. Don't forget that the side of the house facing the wind will have a much more even temperature due to the air washing that occurs on the surface, which masks any temperature differences. And any surface facing the sky will cool off on clear days or nights as heat radiates into space.